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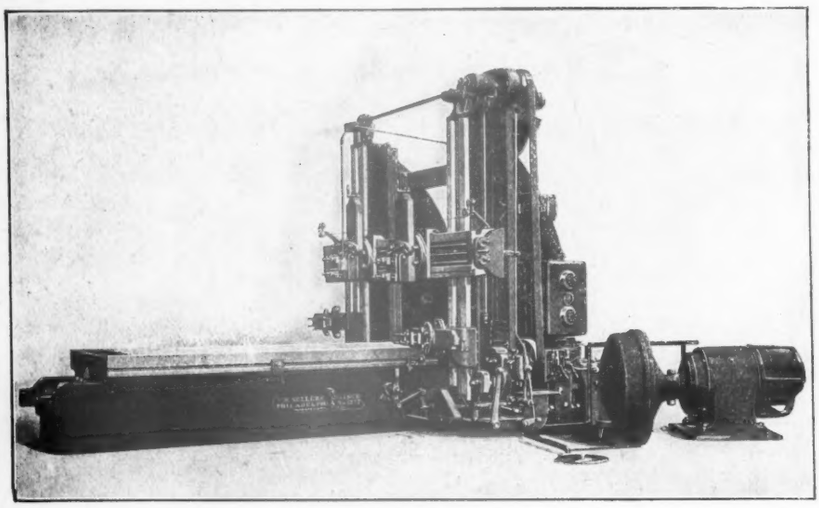

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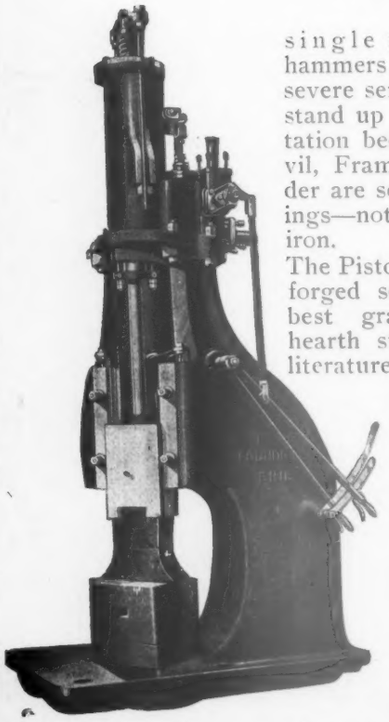

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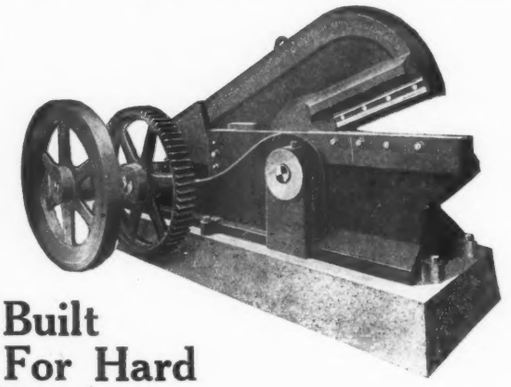

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Railway Mechanical Engineer

Volume 90 July, 1916 No. 7

Automatic Fire Doors

In the days when the old swing type fire door was in general use, while it was customary to keep the door closed between shovelfuls, it was not generally known to what extent the cooling action of the air rushing through this opening affected the firebox temperature. The cold air streaming into the firebox not only lowered the temperature of the products of combustion and the sheets near the rear end of the firebox, but it struck the tube sheet in such a way as to result in leaky tubes and frequently in engine failures. The brick arch has done much to prevent this cold air getting to the tube sheet but the automatic door accomplishes a great deal by keeping a considerable amount of it from getting into the firebox at all. Of course, it is impossible with hand firing to keep the fire door closed all the time but the automatic door reduces the colling effect to a very great extent because of its requiring the opening of the door for a much smaller period of time for each scoop of coal than with the old swing door. In addition, a feature which should not be overlooked is that of the added safety provided by the automatic door in case of a burst tube or any other accident which causes an accumulation of pressure in the firebox. There are records of a great many instances of enginemen being saved from severe scalding due to the use of the automatic door.

Saving Oil and Wasting Fuel

"I am willing to use an extra five cents' worth of oil to save a dollar's worth of coal." This statement was made by the mechanical superintendent of a large eastern road in discussing the report of the Committee on Superheater Locomotives at the June convention of the American Railway Master Mechanics' Association. How many other railway mechanical men consider the oil and fuel problems in conjunction in this way? Not very many, judging from the mania for reducing oil consumption that is so general. It is quite right to economize in every way possible—only, see that the economy is real and not false. There are too many roads that are tending to a reversal of the conditions—burning a dollar's worth of coal to save five cents' worth of oil. Proper lubrication of valves and cylinders prevents cutting and consequent blowing; a very slight falling off from the needed amount of oil will frequently be the means of valve and piston leakage that will send no inconsiderable amount of live steam directly into the exhaust passage and out the stack. The steam that escapes thus is an absolute waste, but what is still worse, the coal that was burned in making it into steam is also wasted. By all means stick to the practice of getting every possible *economical* engine mile from a pint of valve oil—but always be sure that it *is* economical. The waste in fuel is not the only waste that results from insufficient lubrication; there is extra wear and tear on other parts of the locomotive that causes increased maintenance charges. But if the lubrication is well enough taken care of to prevent increased fuel consumption, such other troubles will be remedied, and the fuel consideration is therefore an excellent one to keep in mind when there is any temptation to cut oil allowances too fine.

The Weight of Steel Freight Cars

There does not seem to be the same amount of objection raised that there was a few years ago to the weight of steel freight cars reaching figures as high as 48,000 and 50,000 lb. It is probable that the car designers are gradually getting the higher officers educated to the idea that a reasonable amount of weight must be placed in a steel car if it is to have ample strength. While there are still too many of the flimsily built type of car being turned out, a great many railroads, following the lead of one or two of the larger ones, seem to have come to the conclusion that it is better to haul a slightly heavier dead weight than to build a car that is all that could be desired as far as lightness is concerned, but which spends a large proportion of its life on the repair tracks. This is one of the numerous matters in railroad work that require careful consideration to arrive at the correct balance between increased operating costs due to heavier cars and increased maintenance costs due to cheaply built cars. Of course, there is a point beyond which dead weight should not be permitted to go, and it is the work of the designer to keep from going beyond this point, i.e., to provide a car with maximum strength and the least possible dead weight consistent with this.

How Can the Car Designer Improve?

In the April issue a competition was announced in which prizes of ten dollars each were offered for the three letters offering the best suggestions as to how improvements in car design might be effected. This competition closed June 1, 1916, and on another page in this issue will be found the three prize-winning letters. These were submitted by C. H. Faris, Benson, Neb.; Charles E. Wood, foreman freight car repairs, Union Pacific, Kansas City, Kan., and Dennistoun Wood, Palo Alto, Cal. It is worthy of note that the point most frequently touched on in the letters submitted is the lack of a sufficiently close relation between the designer, the transportation department and the car repair forces. The need of co-operation between these three organizations is self-evident; yet there seems to be considerable difficulty in the way of bringing about a satisfactory relationship which will work toward that end. The plan outlined in one of the three letters appearing in this issue, whereby the various members of the drafting room force are more or less regularly to be brought into personal touch with the repair forces and given an opportunity to study defects in design at first hand, is worthy of careful consideration. The time thus spent by the designer away from the drawing-table will be more than repaid by the

clearer appreciation of, and the increased ability to cope with, certain phases of the problem of designing new equipment which are now too often overlooked.

Mechanical Stokers and Fuel Economy

In the discussion of the report on mechanical stokers at the convention of the Master Mechanics' Association last month it was stated that the mechanical stoker is not a fuel saver. So far as is known, the claim of economy in fuel has never been made for this machine; on the contrary, it has been stated by some of the manufacturers that they realize that it does not save fuel. The stoker does, however, increase locomotive capacity and provide a means of attaining the full boiler capacity on locomotives of a size on which this could not be obtained by hand firing. That it is accomplishing this in a satisfactory manner is evident from the statement, also made at the convention, that there is record of 30 stokers firing 30 locomotives an aggregate of 1,000,000 miles without a single case of failure. Because the mechanical stoker is not now a fuel saver, however, it does not necessarily follow that it may not be in the future. The machine has now been developed to a point where it is performing exacting service in a very satisfactory manner, and the probability is that the manufacturers are now in a position to work more along the lines of refinements such as would probably be necessary to produce an actual saving in fuel consumption. With the actual perfecting of the stoker, as far as ability to do its work is concerned, accomplished so well, there seems no doubt that the ability which has overcome all obstacles so far will continue improvements tending toward a still better and more economical machine.

Superheated Steam in Switching Locomotives

Evidence is not lacking that the railroads have begun to appreciate the value of the use of superheated steam in switching locomotives. There are now in service over 800 switch engines which are equipped with superheaters, and at a conservative estimate, 75 per cent of those now on order are to be so equipped. So far as we know the first application of superheaters to this type of locomotive was made several years ago to a locomotive on the Lake Shore and Michigan Southern, now the New York Central, and the results of tests of this engine were so satisfactory that several other roads purchased switch engines with superheaters. It is not surprising that the results have been so satisfactory when it is considered that because of the excessive cylinder condensation in saturated steam switch engines the rate of water consumption runs as high as 50 and sometimes 70 lb. per indicated horsepower hour, so that it is easy to believe that if the application of the superheater did nothing more than effect a material reduction in cylinder condensation with a consequent lowering of the water rate, the resultant saving in fuel would justify the additional investment. The reduction in the water rate means a consequent reduction in the number of times the tender has to be refilled, with a similar reduction in the amount of time which the engine is out of service in moving to and from the water tank. Furthermore, the saving in fuel means less fuel passing through the firebox and it is therefore possible to go longer without cleaning the fire. It may be said that as the engine crew has to stop for meals, the fire can be cleaned at that time, but when traffic is congested it frequently takes an engine several hours to get its turn over a congested cinder pit, so that if it is possible to do without having the fire cleaned it is evident that a considerable increase in the working time of the engine in times of heavy traffic can be obtained. It has been abundantly demonstrated that the work in any given yard can be accomplished with a smaller number of superheater engines than would be required if saturated steam engines were used. In other words, a given switching capacity is obtainable with a smaller investment for power, if superheater engines are used.

The Cost of Locomotive Maintenance

Complaints are heard continually about the increasing cost of maintaining locomotives. In some of these complaints specific reference is made to some device which, while increasing the locomotive's economy, is of such a nature that it is expensive to maintain. The trouble with some of our railway men is that they expect something for nothing. When any new and important development is made in the locomotive, unless it can be conclusively shown that the maintenance charges are not going to be increased by its use they at once condemn it. No piece of machinery can reasonably be expected to run without being properly maintained and the trouble in a great many cases is that railway men do not grasp the proper balance between the resulting improved operation of the locomotive and whatever increase in maintenance expense there may be. A great deal has been made of the saying that anything applied to a locomotive must be fool proof and undoubtedly the greatest possible simplicity is desirable because of the working and repair conditions which obtain in locomotive practice. But if all mechanical department officers fully realize the benefits which the operating department is receiving from many of the special features of present day locomotives, they should not object to a reasonable increase in maintenance costs nor to bringing their roundhouse practice up to a higher standard in order to take proper care of these devices so that their full possibilities may be realized.

Can You Do This?

Many car and motive power departments are now giving attention to the problem of recruiting their ranks and offering some sort of training for apprentices. Even on the very few roads which are doing really good work in this respect, however, there are many mechanics and skilled and unskilled workers who have passed beyond the stage when they can take advantage of such instruction, but who still desire further to perfect themselves in the calling which they have chosen, and to fit themselves for promotion. Some day the railroads generally are surely going to awaken to the necessity of helping these men by advice and by planning courses of instruction for them. Meanwhile they are being played upon right and left by all sorts of fake schemes advocated by unscrupulous, glib-tongued solicitors, who get as much money as they can from the men, with big promises of what they will do for them. Then, even though in some cases the material which they give them is good, they leave them to themselves and provide little or no incentive or encouragement for them to follow up the courses for which they may have enrolled. In some cases the courses which are offered are all very good, but are sold to men who cannot possibly take advantage of them and ought never to have been urged to take them up. Where can the men go for advice when they are approached with a proposition of this kind? Ought not the railroads to assume the responsibility of giving them honest, wholesome advice as to where they can get the most for their money, at least until such time as the railroads themselves can individually supervise the developing and planning of educational courses for all of their men? What these men are usually after is concrete data which can be practically applied to their own problems, and there are few agencies which are prepared to offer such courses of study to the different classes of men in the car

and locomotive department. Responsible officers of each road ought to investigate these agencies and see that they give the men a square deal.

Four-Wheel Trucks for Passenger Cars

The steel day coaches of the Boston & Maine, described in another part of this issue, are mounted on trucks of the four-wheel type, thus placing this road in the list of those whose officers believe that six-wheel trucks are not necessary under modern steel coaches. The Pennsylvania Railroad has for years used four-wheel trucks as standard under its 70-ft. steel coaches, weighing practically the same as those of the Boston & Maine, while the Philadelphia & Reading is operating trucks of this type under steel coaches in its fastest service. There does not seem any good reason why four-wheel trucks should not give entire satisfaction under steel coaches, considering the matter from the standpoints of safety, smoothness of riding and cost of maintenance; and when the cost of conducting transportation is considered, there is a very good argument against the six-wheel truck in its additional weight. A reasonable figure for the extra weight per car due to six-wheel trucks is 15,000 lb., so that in the case of the Boston & Maine cars, if six-wheel trucks were substituted for those of the four-wheel type, the additional weight in an eight-car train would be 120,000 lb., or equivalent to slightly more than the weight of another car. In other words, considering any given division on which a locomotive can haul eight cars fitted with six-wheel trucks, the same locomotive can haul nine such cars if they are mounted on four-wheel trucks. As the cost of maintenance of trucks of the six-wheel type is probably 50 per cent greater than that of four-wheel trucks, the latter type would seem to be preferable for use under passenger equipment cars, where the light weight of the body does not exceed that of the ordinary day coach.

Lateral Motion Driving Boxes and Side Play

In his address at the opening session of the convention of the Master Mechanics' Association, President Pratt said: "There is great promise in the floating axle scheme, or some development of it, although it may require a change in the restricted side play now permitted by Federal rule and agreement." The floating axle referred to is the means of increasing the flexibility of driving wheelbase which is now employed on a large number of locomotives, the first ones equipped being the 2-10-2 type engines for the New York, Ontario & Western. It is felt, however, that this reference in the president's address may lead to misapprehension and possibly result in railway men raising a question as to the possibility of the lateral motion driving axle running contrary to the Interstate Commerce Commission's requirements. In order to correct any such impression there is given below paragraph 40 of the order of the Commission, dated October 11, 1915, which deals with lateral motion:

> The total lateral motion or play between the hubs of the wheels and the boxes on any pair of wheels shall not exceed the following limits:
>
> For engine truck wheels (trucks with swing centers).....1 in.
> For engine truck wheels (trucks with rigid centers).....1½ in.
> For trailing truck wheels.....1 in.
> For driving wheels (more than one pair).....0¾ in.
>
> These limits may be increased on locomotives operating on track where the curvature exceeds 20 deg. when it can be shown that conditions require additional lateral motion.
>
> The lateral motion shall in all cases be kept within such limits that the driving wheels, rods, or crank pins will not interfere with other parts of the locomotive.

From the foregoing it is evident that the order clearly defines that the lateral motion or play shall be measured between the hubs of the wheels and the boxes. On the lateral motion driving axle the play between the boxes and the wheel hubs is kept at a normal figure. On many of the designs arrangements have been made for a take-up of lateral wear so that the side play may easily be kept at any desired amount without removing the wheels and boxes from the locomotive. All the lateral motion boxes have been so arranged that there is ample clearance between driving wheels, rods and crank pins and other parts. It should be evident, therefore, from what has been said and from the quotation from the Commission's order, that there is no likelihood of any ruling on the part of its inspectors which would prevent the use of this type of axle.

NEW BOOKS

Mechanical Engineers' Handbook. Lionel S. Marks, professor of mechanical engineering, Harvard University and Massachusetts Institute of Technology, editor-in-chief. Bound in morocco. 1,836 pages. 4½ in. by 7 in. Illustrated. Published by the McGraw-Hill Book Company, Inc., 239 West 39th street, New York. Price, $5.00 net.

The field of mechanical engineering has become so extended that it is no longer possible for a single individual, or a small group of individuals, to have sufficiently intimate acquaintance with all its branches to permit a satisfactory exercise of critical judgment in the statement of current practice and the selection of engineering data. The only existing reference work for mechanical engineers, compiled by a large group of specialists, is the three-volume German book "Hütte," now in its twenty-second edition. This book, however, includes civil and electrical engineering, as well as mechanical engineering. It has been continually improved for over fifty years, and is now the accepted authority within its range of topics. This work has been used as the basis for the new handbook. In only a few of the more theoretical sections, however, has the "Hütte" been followed at all closely. The greater part of the book, however, particularly those portions which deal with engineering practice, is wholly new.

The subject matter groups itself into two main divisions, the first 860 pages being devoted to the more theoretical topics and the last 960 pages to the statement and discussion of current practice. The first portion is divided into seven sections as follows: Mathematical Tables and Weights and Measures; Mathematics; Mechanics of Solids and Liquids (including Friction); Heat; Strength of Materials; Materials of Engineering; and Machine Elements. The portion treating of practice is divided into eight sections dealing with Power Generation; Hoisting and Conveying; Transportation; Building Construction and Equipment; Machine Shop Practice; Pumps and Compressors; and Engineering Measurements, Mechanical Refrigeration, etc. The total list of contributors numbers 50 specialists, each of whom is qualified to speak authoritatively on the subject assigned to him. In order to further increase the accuracy of data and to insure that the subject matter is not solely the practice of an individual, but is truly representative, a number of the contributions which deal with engineering practice were submitted by the editor-in-chief to one or more other specialists for their criticism before finally being incorporated in the handbook.

This book is the most thorough and comprehensive mechanical engineers' handbook adapted to American practice, if not in the English language, and its usefulness is considerably enhanced by certain features of the make-up. Both the front and back covers contain an index to major topics and a list of the more important tables is given on each flyleaf. The book is provided with thumb tabs so that the reader, after looking at the index on the covers and finding there the section number, may turn immediately, by use of the thumb tabs, to the section in which he is interested. The important reference tables have the page reference so that they can be turned to immediately. The index is unusually complete and well arranged.

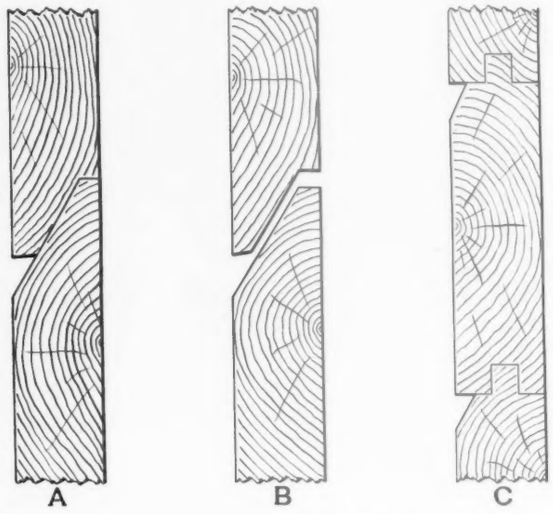
COMMUNICATIONS

HORIZONTAL SHEATHING FOR BOX CARS

Chicago, Ill.

To the Editor:

I have noted the suggestion for a new type of joint for horizontally sheathed box cars which appears in the *Railway Mechanical Engineer* for June, page 276. For the one purpose which was suggested, the change would probably be effective. Reference to the accompanying sketches, however, throws another light on the matter. In the sketches *A* represents the joint when the boards were new and *B* when they have shrunk to some extent. It will be noticed that *B* opens



Horizontal Sheathing for Box Cars

a passage from the interior to the exterior of the car which is practically unobstructed. This would render this joint useless for grain cars. The other sketch which I have marked *C* shows the standard M. C. B. section for 1½-in. sheathing for this type of car. In this the only change I would suggest is as shown in the sketch, namely, the beveling of the upper outer edge of the board. This will, I believe, take care of any possible condition of this kind.

W. E. Fowler,
President, Fowler Car Co.

MORE FROM TOBESURA WENO

(With apologies to Wallace Irwin)

Chicago, Ill.

Dear editor:

As I report in previous letter aforesaid as honorable colleague Brandeis, associate supreme court justice-elect would emit, I am become U. S. Federal I. C. C. detector. Of late, when I was watchful waiting on obscure rr. locomotive, I were beset by large member brotherhood as follows:

"Say, guinea" (exact epitaph used—dictionary explain kind of fowl) "guess you know where the kale comes from, what?" I reply I not familiar with sandhouse joke and are representing U. S. government. "Oh yes, he retort, legally, technically like Cliffie Thorne represent Hon. Commission of Iowa—but I mean you are become wise to who keeps you in job." I have no response and he reply—"It's us—we're the boys what produces fat bonanzas for such as you. So you want to come across with the goods and put bed springs and cushions on these ornery hogs." He continue a little submerged as foreman approach—"You see those windows—as dirty as them in my old woman's kitchen and glimpse the clinkers on the running board; behold the dent in the stack; feel the greasy handrail, look at the coal in the gangway, the raggedy storm curtain. And would you believe it, cold water squirt nowadays. How's a man gonna wash up in icewater? Why can't the fireboy have a foot-rest and a back cushion too?" He also suggest a washbowl and mirror. I hastily apologize for unsanitary predicament, promise to confer with Chief Detector in Washington and escape on rear self-serve ashpan bracket. On account of recent arbitration hearing, I report—"Dent in smoke stack, right back corner; cab window too dirty for safety and squirt pipe bad design and require new hose." It are also remarked "that boiler dirty and require paint, hinge loose on tool-box, one sand pipe behind rear driver instead of in front, oil can leaky, headlight require more Standard oil, and air pressure too much in bell as it completely revolve."

I stop then as I have soft heart for railroad sometime and can get remains next time. Yours truly,

Tobesura Weno.

COLLEGE MEN IN THE MECHANICAL DEPARTMENT

Philadelphia, Pa.

To the Editor:

Your editorial on "College Men in the Mechanical Department," in the *Daily Railway Age Gazette* of June 22 was received with many feelings of an old friend.

It is my belief that the railway mechanical departments can get all the college men they want, and even all that they need. If a college graduate looks for a place with the railroad he is likely told that the chief is out on the road and it would be best for him to write; if he writes he is fortunate to receive a reply which states that there is no opening; and if he has the good fortune to see the man himself the answer is almost certain to be "Sorry, but we have nothing for you. I would advise you to try something else."

Some time ago I was working alongside the locomotive designer of a large eastern road. He had served his time as a machinist and was also a university man. The salary he received was about what a good man could earn at the machinist trade. I wished to call his attention to something bearing on a problem that he was then working on. "John," I said, "have you read this week's *Railway Age Gazette?* There is an article that might interest you." "What is it on? Why college men leave the railroad?" was his answer. Thus had the iron burned his soul.

Again, there is my own case. I went to work in the railway repair shop as a boy and after a year went to college. I completed the course successfully, during the summer vacations working in a nearby roundhouse. After graduation I held a couple of odd jobs for a while, and then went to work as special apprentice for a large railroad. The agreed length of apprenticeship went by, but it seemed to make no difference in my status. Finally I got restless and started to make inquiries as to my future. The replies did not measure up as satisfactory, so one day I got tired of waiting, took the day off and secured a position with a manufacturing concern. The next day I told the man I was working for that I would soon be leaving. "I shall be sorry to lose your services. Wait and I will see what I can do for you." So in the goodness of his heart he went and saw the superintendent of motive power, who told him that he could raise my wages to a point that would almost equal what I would have been receiving some years before had I finished serving my time as machinist. I was tired of butting my head against a stone wall and faded from the railroad service.

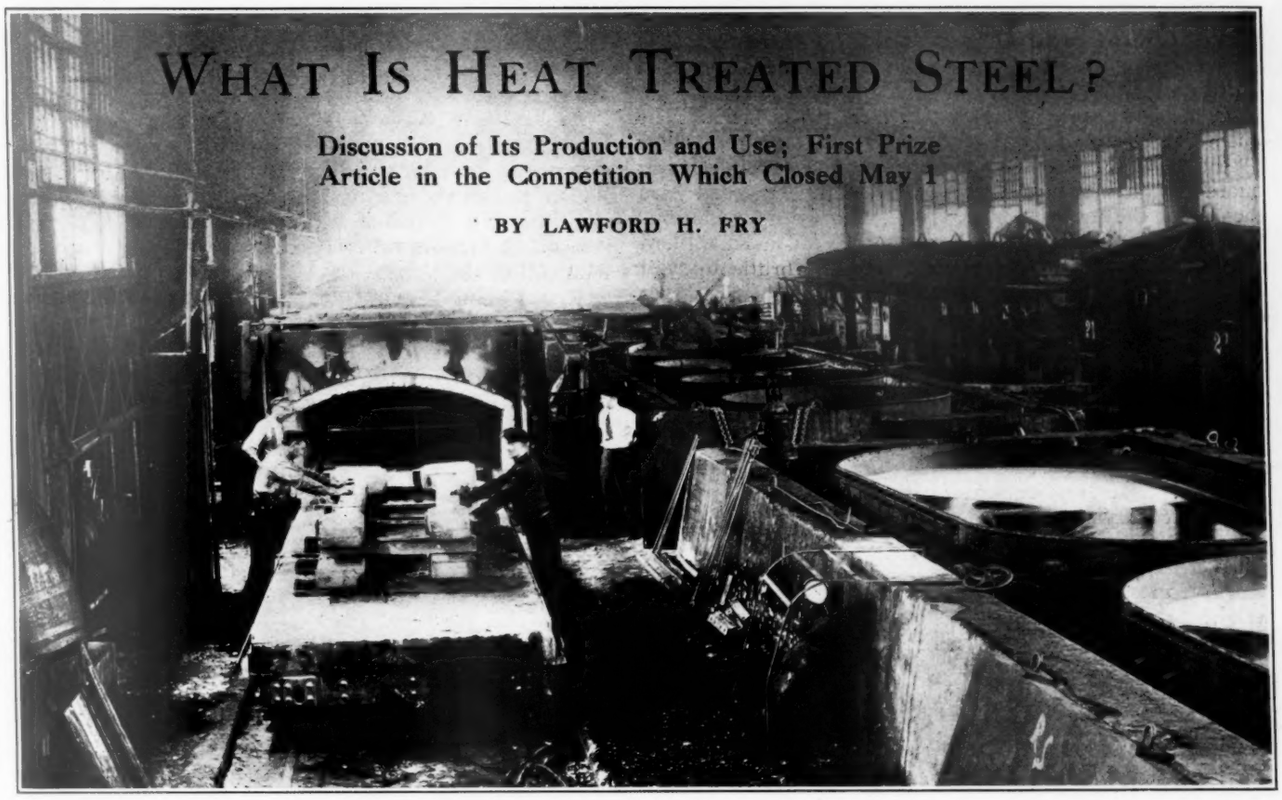
I cannot see where there lies any value in the suggestion that the railroads pick out men and send them to college. Unless the railroads experience a great change of heart these would only do as so many of us before them have done: work a while, notice that the opportunities outside were greater, get tired of charging their efforts to experience, and go out into the world to make a real living.

George S. Clouser.

What Is Heat Treated Steel?

Discussion of Its Production and Use; First Prize Article in the Competition Which Closed May 1

BY LAWFORD H. FRY



Heat Treating Plant, Standard Steel Works Company, Burnham, Pa.

Heat treatment is much like strong medicine. Applied by a skilled doctor under proper conditions, it gives excellent results, but in unskilled hands the consequences are disastrous. In fact, after reviewing some of the early unhappy examples of heat treatment one might well borrow Madame Roland's phrase regarding liberty and exclaim, "How many crimes have been committed in thy name!" Though mistakes have been made in the past it is undoubtedly true that the net balance is on the credit side, and that the field for the use of properly heat treated material is bound to extend.

Our aim here is to discuss the proper production and the proper use of heat treated material for railway service. The most important phases of the subject are brought out in the following four questions and answers and the facts on which the answers are based are examined later in detail.

Q. 1.—What advantages has heat treated material over untreated material, and when should treated material be chosen?

A.—Heat treatment gives to steel a high elastic limit and high tensile strength combined with good ductility. As a consequence greater strength with the same weight and dimensions, or less weight with the same strength can be obtained. The treated material should be chosen when these advantages outweigh the higher cost.

Q. 2.—How are the above qualities obtained?

A.—By heating the material to the proper temperature, quenching it in oil or water to confer great strength and hardness, and reheating to a lower temperature to remove some of the hardness and restore ductility.

Q. 3.—What is necessary for the production of satisfactory heat treated material.

A.—Sound and carefully selected steel, knowledge of the proper temperatures to use, furnaces and apparatus for accurately obtaining and measuring these temperatures and a proper installation for quenching.

Q. 4.—What precautions are necessary in repair work on heat treated material?

A.—Any bending or straightening must not be done cold, but at a temperature of between 900 deg. and 1,000 deg. F. No higher temperature must be used, or the special properties given by the treatment will disappear. Retreatment should never be attempted except where heat treatment is usually done and where apparatus and experience are available.

So far we have spoken of heat treated steel without specifying forged or cast steel. While some heat treated castings are used, heat treated forgings are more important in railway work and in what follows attention will be directed to them; the greater part of what is said about heat treatment, however, will apply to castings as well as to forgings.

The quality of any forging and its suitability for service depends on two things, first on the chemical composition of the steel, and second on the physical structure of the steel as determined by the working and heating it has undergone. The chemical composition is fixed at the time the ingot is poured, but the physical structure as disclosed by the microscope is varied by every operation of heating or working. In the ingot the structure is large grained and open, corresponding to a moderate hardness and low ductility. As the ingot is reduced to a billet by rolling, the grain becomes finer and the structure more compact, the exact condition depending on the amount of work done on the steel and the temperature at which it is done. The same process of improvement by refining the grain also takes places when the billet is made into a forging. Both the strength and the ductility of the metal are increased and it is in much better condition to resist stresses and shocks. It is difficult, however, to control the temperature at which the forgings are finished, and impossible to have the temperature at which they leave the hammer uniform throughout. As a consequence the structure of the steel will not be uniform and the unequal cooling may set up severe shrinkage strains. To eliminate these strains and to secure a uniformly satisfactory structure it is desirable, in the case of forgings for railway service which are not to be heat treated, to heat them to a temperature which will refine the grain and then allow them to cool uniformly,—in other

words to anneal them.* The consequences of the annealing are a slight loss in tensile strength and a considerable gain in ductility.

In the heat treated forging a further step is taken. The quenching refines the grain still further and establishes a new condition in the structure, conferring on the steel superior qualities which cannot be secured otherwise. Observed from the outside the steel is seen to be heated to a certain temperature and then quenched in oil or water. This makes it hard and brittle; too hard to machine and too brittle to stand shocks. It is therefore tempered by being reheated to a lower temperature and allowed to cool slowly. This reheating removes some of the hardness and gives ductility. The extent to which the drawing of the temper is carried will depend on the service for which the forging is intended and the qualities desired. Viewed internally, by means of the microscope, it will be seen that the quench greatly refines the structure and introduces another modification which tends to disappear on the draw. The exact reasons for these changes may be left to the metallurgists. The facts of practical importance are that as steel is heated it passes through a certain critical range of temperature in which its structure changes to a form which, if preserved when cold, will produce a very hard material. Slow cooling allows this structure to disappear, but by rapid cooling, such as quenching, some of this hardening structure can be retained. The more rapid the quenching, the more nearly is the hardening structure retained and the harder will be the steel. As the steel is reheated after quenching the hardening structure gradually disappears and by stopping the reheating at the proper point any desired degree of hardness below that given by the quench can be obtained. If the reheating is carried to the critical temperature all of the hardening structure will have disappeared, to reappear after the critical temperature has been passed. The steel will now be in the same condition as before quenching and will be soft if cooled slowly (annealed) or hard if again quenched.

One of the problems of heat treatment is to determine the location of this critical temperature, and to decide on the margin above it to which the steel should be heated before quenching. A certain margin is necessary to secure satisfactory results in practice, but if this margin is exceeded the grain will be coarsened. It is impossible to give general rules for quenching temperatures because so much depends on the composition of the steel, the design and dimensions of the forging and on the conditions of the quenching. Under the conditions described below a temperature of 1475 deg. F. in the furnace before quenching will give satisfactory results with a locomotive driving axle of steel containing 0.40 per cent carbon, but a different temperature would be required if the carbon content be changed or if alloy instead of carbon steel be used.

The standard forging specifications of the American Society for Testing Materials will serve to compare the properties of heat treated with those of annealed forgings. Taking for example a locomotive driving axle about 11 in. in diameter, the minimum tensile properties required for carbon and alloy steel are as follows:

Material.	Elastic limit lb. sq. in.	Tensile strength lb. sq. in.	Elong. in 2 in. per cent	Reduction of area per cent
Carbon—annealed 40,000		80,000	21.6	33.0
Carbon—quenched and tempered..50,000		85,000	22.3	42.3
Alloy—quenched and tempered...65,000		90,000	20.0	50.0

Generally speaking the allowable working fibre stress is determined by the elastic limit so that in the carbon steel the quenched and tempered material is 25 per cent stronger than the annealed material.† By substituting heat treated alloy steel for the annealed carbon steel the strength can be increased over 50 per cent.

As has been pointed out, under conditions in which this increase in strength is worth the increased cost, the treated material is desirable. As an instance of this kind consider the valve motion and reciprocating parts of a locomotive. Weight here is a great disadvantage and at the same time the use of high grade material will not very greatly affect the total cost of the locomotive.

In producing heat treated forgings, the first problem to be encountered is the selection of sound steel. This is a difficult subject, for while it is well recognized that the steel must be of good quality it is not easy to lay down hard and fast rules for its selection. One large consumer specifies that the carbon segregation between centre and outside shall not exceed 12 per cent, but this requirement has not yet stood the test of time. For our purpose it will therefore be assumed that the manufacturer, by the best use of his judgment and his conscience, will choose good steel and forge it by proper methods.

In the process of quenching and tempering two points require consideration: the heating and the quenching. It is essential that the heating be done uniformly and accurately. The furnace should be so designed that at no point will the temperature vary more than 10 deg. to 15 deg. F. from that desired, and should be equipped with sufficient pyrometers to enable the operator to be certain that this degree of accuracy is being obtained. The quenching system must be placed so that the heated material can be transferred to it from the furnace without loss of time or temperature. It must also be arranged so as to extract from the material the required amount of heat at the desired rate. Here, in the quenching system, the success or failure of the treatment will be determined and it is here that experience is necessary.

In quenching the balance must be held between two conflicting requirements. Rapidity of cooling is desirable to retain the hardening structure, but brings with it severe shrinkage strains which, if not controlled, may destroy the material. To illustrate the character of the shrinkage strains and the damage they may cause, a locomotive driving axle will be considered. On entering the quenching medium the outer surface is chilled by contact with the fluid and therefore tends to contract, while the inner part of the axle, not having the same opportunity for cooling, does not shrink in the same proportion. As the outer surface shrinks it has to adapt itself to the enlarged central core and in so doing must be stretched. If the cooling of the surface is too rapid or if there is any considerable seam or flaw, the stretching necessary for adjustment may be beyond the capacity of the steel, and a longitudinal crack may start in the outside surface. If the cooling is somewhat less rapid the outer shell will adapt itself to the hot core; then, as the cooling effect penetrates, a shell next to the surface shell cools and stretches, and this action is continued. It will be seen that as the end of the cooling approaches the axle consists of an outer cylinder stretched but rigid, enclosing a central core which, in order to complete its cooling, has to undergo a shrinkage tending to make it occupy less space than that held for it by the cooled cylinder. This sets up a very considerable stress at the centre of the axle and if the cooling is allowed to complete itself too rapidly a radial fracture will be set up starting from the centre of the axle.

For convenience an axle has been considered, but a similar condition will be found in any forging having any considerable thickness. In a bored axle the shrinkage strains are much less than in a solid axle, for two reasons. First,

*The editor, in announcing the competition, used the term "heat treatment" in the sense of quenching and tempering, and his example has been followed. As a general rule it is better to follow the usage of the American Society for Testing Materials in the standard specifications for forgings, which contain the following definition: "Heat treatment may consist of annealing or quenching and tempering."

†This is a conservative statement as the figures given for the annealed forgings are for yield point and not for elastic limit, while for the treated material the elastic limit is given.

the quenching fluid acts both inside and outside, producing more uniform cooling; second, the hollow cylinder is a less rigid form and avoids the difficulty of the final cooling of the central core.

So far we have considered only the shrinkage in directions perpendicular to the axis of the axle, but a very similar action takes place in a direction parallel to the axis. A chilled, rigid cylinder is formed enclosing a hotter cylinder which has still to complete its shrinkage. In the final shrinkage if too rapidly completed, the middle part of the core may pull away from the ends, a transverse fissure starting in the interior of the axle and not emerging through the outer shell until some shock is received after the treatment is completed.

To avoid internal fissures it is desirable not to let the forging cool all the way down to the temperature of the quenching medium, but to remove it from the tank and send it back to the furnace for drawing the temper while the temperature of the interior is still 400 deg. or 500 deg. F. During the reheating and subsequent cooling the shrinkage strains have time and opportunity to equalize.

The external cracking first mentioned is less likely to occur than the internal cracking and will only take place if the material is defective or if the quenching medium gives too severe a shock when the forging is first dipped.

Water, heavy oil, a mixture of oil and water and many special brands of quenching oils are advocated and used as quenching mediums. Water has the advantage of conferring excellent physical properties by reason of the rapid cooling, but for the same reason will produce dangerous shrinkage strains unless the cooling is very carefully timed. Heavy oil, such as cylinder oil, greatly reduces the danger from cracking, but quenches more slowly and therefore does not produce such good physical properties in the steel. With a view to reducing the danger of damage by water and at the same time to securing better results than can be obtained with heavy oil, various other quenching fluids are used. Some manufacturers use a mixture of oil and water similar to a drilling compound, while others use light oils of different grades. The light oils introduce a fire risk, but this need not be serious if sufficient volume of oil is provided and steps taken to prevent its temperature from being unduly raised.

The writer advocates the use of an inexpensive light mineral oil with a fire point of about 390 deg. F., a flash point of about 350 deg. F. and gravity about 29 deg. Baumé. There should be separate quenching and storage tanks, the latter to have ample capacity and to be provided with cooling coils. The oil should be pumped from the storage into the quenching tank and delivered into the latter in such a way as to produce a vigorous and positive circulation about the object to be quenched. A system of this kind has many advantages, one of the most important being that since the circulation of the oil is controlled by the pump, the rate of circulation can be varied, and the rate of cooling thus adapted to suit the needs of almost any case. Experience will show the rate of cooling desirable for each class of forging and good results can be obtained with small risk of cracking. To be on the safe side and to avoid any possible trouble with internal cracks it is considered good practice to apply a proof test to every heat treated forging. This usually takes the form of a drop test sufficient to eliminate any defective, but not sufficient to injure any sound forging.

With a quenching system as described, with care in its use and in the selection of the steel, and with a proof test on each forging after treatment, manufacturer and consumer can rely on the product being uniform and satisfactory.

It is undesirable to attempt to bend or to straighten heat treated material cold, as this will set up cold work strains. At the same time it is obvious that if the temperature be carried above that at which the material was drawn, the strength conferred by the treatment will be lost. It must always be remembered that heat treated material possesses its good qualities because it has been heated to certain temperatures in a certain way and that if heated again to these temperatures the quality will be affected. It should be obvious from what has been said that material cannot be retreated at a repair point unless full equipment and experience are available.

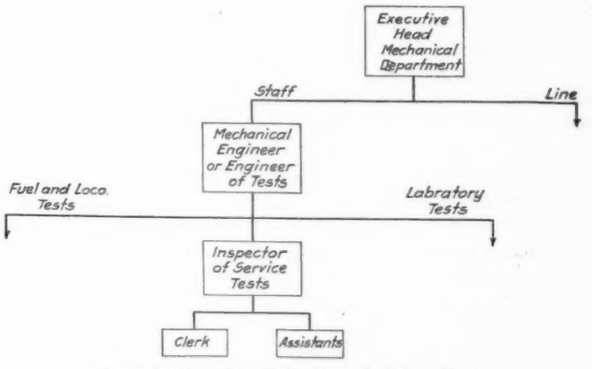
KEEPING TRACK OF SERVICE TESTS

BY E. S. BARNUM

Economy has become the watchword of railroad management. Possibly the conditions which make rigid economy necessary are forced and unhealthy, but they are none the less real. Unhealthy economy usually consists of seeing how few dollars you can spend, but healthy economy consists of spending all the dollars necessary and seeing that each one returns 100 cents of value.

Of the money spent by the mechanical department, roughly, one-third goes to labor, while the other two-thirds goes for material. Labor means output, and a survey of the situation will show that due to the pressure for output and other causes, labor, the smaller of the two divisions of the expense, receives the major share of the attention. Of course, the quantity of material bears a relation to the output, but the quality does not.

There is a large amount of material, running into sums of money which can be measured only by actual service. To follow up and secure a measure of the value of material in service sounds simple, but in fact it is one of the most



Organization for Following Service Tests

difficult and exacting tasks imaginable. Equip a few locomotives with test air pump packing, tag the pumps, and then, without giving them any more attention, allow them to run for a short time, say two months. At the end of this time take out all the packing and tabulate the results. Test packing rings and standard rings will be found in the same pumps and the sum total will be a hopeless jumble that defies analysis. At one time a test was run on some steel wheels to determine their mileage between turnings. The wheels were all calipered for diameter, and put under locomotive tenders. At the end of a few months the wheels were calipered again, and on comparing diameters what was the surprise of the investigator to find the wheels slightly larger than when they were put in new. It was then discovered that the man who made the initial measurement of diameter was not a skilled hand at using calipers. If a little more time had been allowed to elapse between observations, the evidence of error would have been obliterated, and the wheels would have been given credit for wear to which they were not entitled.

In general, the more people there are who know that a material or device is under test, the more apt you are to get accurate results, for the reason that what escapes one man will be reported by someone else. Working on this prin-

ciple, there are usually a lot of circular letters sent out every time some material is put under test in service. Circular letters have a useful function, but when they are received frequently, written by the same person in the same dry style, the men who get them do not get very far before they "get wise," and this is about the result: Roundhouse foreman or car inspector, reading from a letter. "Dear Sir—In order to determine the relative value of our standard brake shoes as compared with the shoes manufactured by the X Y Z Company, it is desired to equip ——" Here the reader breaks off to remark: "Ain't it the limit. Seems like those fellows up there don't do nothin' but sit around and figger out how much trouble they can cause us. They don't ever do no worryin' about how we are going to get all this work done." Having delivered himself thus he continues to read, but in a disinterested way, his mind having received a "permanent set" against the job in question.

Why should not this letter have read, "Our yearly bill for brake shoes is (naming the correct total) —— dollars. If we can get a shoe that will give a few more hundred miles than the one we are now using, and equally as good otherwise, we can make a saving which, though small considering each shoe, will mean a considerable saving on our cost of brake shoes for the year. We are going to try the X Y Z Company's shoes, and will you kindly equip, etc." This form has a personal appeal. Pay the average employee the compliment of considering him an interested party rather than a mere cog, and see how quick he is to take hold.

One of the best examples we have of the value of the personal appeal is the results of the safety committees. The men were approached from the personal side and in many cases personally, to cut down the number of cases of personal injuries. That the return on the investment in dollars and cents has been big, is a matter of record. If the circular letter, designed to reach all persons interested, can be written so that it has personal appeal, good, but—and here comes a most vital point—no circular letter can get the interest or attention that can be gotten by a visit from the man making the test, or one of his assistants.

By paying a visit I do not mean just going into a terminal, standing around like a judge, and dismissing the matter with a bare statement that certain points should be watched and a record kept of results. Before you can get someone interested in a subject you must be interested yourself, and have determined before hand what must be asked and said, and the manner of doing it. Jake is a roundhouse repairman of average intelligence. He was stopped one day while bent over his work, and asked, "You haven't had any trouble with the X fittings, have you?" naming a special fitting. "No," he answered, looking up, "none that I know of," and his eyes meantime had traveled back, restlessly, to the work in front of him. Now, the very form of the question was negative and called for just the answer that was given. Jake's mind evidently was still on his work, and if the questioner had not begun to ply him with some roundhouse gossip of a general nature, he would have been back at it immediately. After a few moments talk the subject of the fittings was again approached in this manner. "Jake, we were looking at some of those X fittings the other day, and they seemed to be weak just back of the shoulder; looked as if they might break there pretty easy." "How do you mean?" he asked, interested, because he had been called on to use his imagination. Following up this lead brought the matter fresh to his mind, and he did remember having some trouble. Later on in the day he looked us up to give us the broken fitting, which he had taken the interest to dig up out of the scrap. The very piece of evidence we wanted.

While these personal touches give life to the job there must be a ground work of routine reports. A report blank may be used to advantage; this should be made out by the sub-foreman or a workman when he makes an examination of any test material. It can be conveniently arranged on a 5 in. by 8 in. sheet, and should have blanks for the engine or car number, the name of the device being tested and the dates of examination, with the condition. It is not expected that one of these blanks be made out every day or even every week unless something of special interest occurs. When the test is started a stated interval for reporting should be assigned for each case. If the report is not received by the time it is due, the man handling this end of the work in the general office should send out a tracer.

What sort of an organization do we need to get results in this work? The amount of money involved is so large that it warrants all the attention and forethought which can be given to determining on the best plan. The man in charge of the testing should be close enough to the executive head of the mechanical department so that he can get all the action he needs. Any go-betweens should be open-minded. The man who is governed by prejudice, who has the habit of eliminating from consideration immediately any subject which does not appear on the face to be feasible, should not be allowed to be a factor in the organization. If there is no other way the man who is the active head should report direct to the head of the mechanical department, eliminating all go-betweens who might interfere with the work. The chart shows a suggested scheme of organization which can, of course, be changed to suit conditions. For lack of a better name, the man responsible for tests of materials, etc., has been given the title of inspector of service tests, and it will be noted that locomotive and laboratory testing are shown as entirely divorced. The inspector of service tests, not having any connection with any other work but his own, is able to devote his entire attention to a job which will assume large proportions if the bills for material are given a close inspection.

In the case of test material placed on equipment which moves from one point to another, it is necessary to check very closely to keep the various shops from removing test parts without reporting it. To get out and try to run down a case of this kind after it has gotten cold would tax the resources of a detective. Every man can supply a large variety of reasons why he knows it must have been removed at some other point. Therefore, do not forget the clerk. He plays the important part of remaining in the office, and attending to the checking up of reports and other routine matters so that the inspector of service tests and his assistants can spend their time on the firing line. Ordinarily the man who oversees service test work has most of his time occupied with other matters, and when it comes time to draw conclusions, he has to depend on correspondence entirely. He has no first hand information, and the men out on the line, knowing they are never checked up, do not burden themselves in writing up the results.

Welding Castings.—Electric or blow-pipe welding of blow-holes and shrink-holes in steel castings is now a practice recognized in specifications. If the defect is not so located as manifestly to make the casting unfit for use, and if the defect is properly repaired, a welded casting is perfectly satisfactory. The defect, however, should be really eliminated, not simply plugged—as was pointed out in a symposium on iron and steel, presented before the International Engineering Congress. By opening a hole to the bottom with the flame or arc, much as a dentist prepares a cavity in a tooth for filling, and then filling it with metal that is welded to the partly fused walls of the hole, the casting can be made truly sound. The hardening effect of the high temperature and rapid cooling upon the steel adjacent to the weld, especially in medium and hard castings, and the stresses set up by the cooling of large welds make it essential in a great many cases that the casting be reannealed after welding.—*American Machinist.*

LOCOMOTIVE SUPERHEATER PERFORMANCE*

A Discussion of Present-Day Practice and the Probable Results of a Higher Degree of Superheat

BY S. S. RIEGEL
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Steam in a boiler in intimate contact with water exists generally at the minimum temperature of its formation, corresponding to the boiler pressure. Under these conditions it is always in the state of vapor, and said to be "saturated." Any increase in temperature will cause a rise of pressure, and any reduction in temperature will cause some of the steam to condense as water. It follows then that steam in contact with water in a boiler cannot be superheated, so a separate chamber, into which it can be passed, is necessary to raise its temperature. A chamber of this kind is called a superheater, and as this chamber invariably opens into the boiler, the steam it contains cannot exist at a higher pressure than that of the generated steam in the boiler, and can only be superheated at equal or lower pressure. This steam is dry and is called "superheated." In this condition it will resist all temperature changes within the full range of the superheat it contains, by reason of its reserve heat. This power to resist the usual condensation losses is the main reason for its use, and this should govern the rise in temperature, the amount of reserve heat, which should be given to the steam. Another most important reason for its use is its property of increased volume, as pound for pound, superheated steam has the greater volume, giving a corresponding gain in economy.

As there are now over 16,000 superheaters of the fire-tube type in service in the United States and Canada, it may be called standard equipment on American railroads and from its general use it is not necessary to go into great detail in describing it or its results, these being well known.

As a result of imperfections in material, methods of manufacture, and improper supports in the smoke-box, some of the earlier headers were not able to withstand the severe service, particularly the internal stresses, due to the rapid heat transfer, and cracks developed between the unit seats in the lower faces of the headers. This was overcome by a later design, providing free movement of the several parts—the loose-finger design, now coming into favored use. This is a through bolt header, providing additional air spaces between the walls of the saturated and superheated steam compartments, to allow for expansion and contraction and avoid a too rapid heat transfer.

Another recent improvement in the American superheater is the re-design of the superheater unit, by the substitution of a welded return bend for the old cast steel form. This new return bend is produced by welding the ends of the units together, through an ingenious combination of machine forging and acetylene welding. The torpedo-shaped ends which result offer minimum resistance to the passage of gases through the large flues and maintain liberal cross-sectional area for the free flow of steam through the units. From a mechanical standpoint the welded end is superior to the cast steel return bend unit, since it eliminates the threaded joints. The unit troubles which are avoided by the new construction are the leakages at the threaded connections between the unit tubes and the cast steel return bends, and the fractures of the tubes at these points from the weakening of the metal by the cutting of the threads.

No general change in the design or practice of operating superheater dampers has been made, although several railroads have made extensive experiments in an effort to do away with dampers, but the results obtained seem to indicate that the dampers still are necessary for continued successful operation. If the damper operates properly, it is not a hindrance in any case.

The maintenance of a permanently tight connection between the unit and header depends largely on the use of proper header bolts, which cannot be stretched beyond their elastic limits when tightened. The importance of this is appreciated when we know that an average man, tightening a bolt with a 36-in. wrench, may set up a tensile stress in the bolt of over 50,000 lb. per square inch. To provide a sufficient margin of safety these bolts should be made of a material with an elastic limit of about 70,000 lb., and an ultimate strength of over 100,000 lb. per square inch. One of the superheater companies, laying particular stress on this important matter, has produced a bolt of this material.

While the economy of a superheater in coal and water is so thoroughly recognized that it now requires little elaboration, there are certain relations between these savings and the resultant increased power output of the superheater locomotive which are sufficiently fundamental to warrant discussion, however well they may be understood. That the increased power of the superheater locomotive is made possible by the water economy of the engine is self-evident, since the superheater means a decreased amount of water per drawbar horsepower developed, while the evaporative capacity of the boiler remains the same. The superheater, therefore, means more power output for every pound of water used by the engine. To utilize the maximum power developed by the superheater, larger cylinders should be used than would be possible on a saturated engine of the same size. This may readily be seen when we remember that a saturated engine gives a maximum power output at from 40 to 45 per cent cut-off. If, however, a superheater is installed in this locomotive, giving 25 to 35 per cent more steam available at the critical point, the cut-off for maximum power output must be increased from 45 to possibly 70 per cent. This increase in cut-off results in less efficiency, due to the impossibility of getting full expansion out of the steam. Increasing the size of the cylinders, by an amount equal to or proportionate to the greater steam volume available, makes it possible to get the same power at a shorter cut-off, thus utilizing the full benefit of the superheat, as well as better expansion in the cylinders.

The conversion of existing locomotives to superheaters is a problem which must be governed by local conditions, and for which no uniform or standard rule can be fixed. The cost of conversion and results to be obtained must be taken into account in each case. In general the modernizing of existing engines by the application of superheaters has permitted such power to keep pace with increased demands from the use of heavier trains, or in the meeting of more exacting service. A study of pull-speed curves will show the power developed by a saturated engine decreasing rapidly after a speed of fifteen miles per hour is reached, and the superheater, sustaining a higher power for a considerable period beyond this, as expressed in tractive effort and drawbar horsepower. This increased power output is obtained at relatively low cost per unit of tractive effort, as compared with the purchase of superheater-equipped new power. Dur-

*From a paper read before the Central Railway Club, Buffalo, N. Y., at the May, 1916, meeting.

ing the year 1915, out of 3,667 superheaters applied in the United States and Canada, more than 2,000 were used on old engines.

It is worthy of note that superheaters are being more generally applied to both new and existing yard engines. This is comparatively a recent development, as it was formerly thought impossible to obtain a sufficient gain in yard service engines to warrant superheating. It is generally supposed that there is not much necessity to superheat switch engines, but engines so equipped handle more cars between longer periods of coaling, and taking of water, and do their work more quickly, so it would seem the superheater is properly adaptable to engines in switching service. There are now nearly 900 superheater switch engines in service in the United States, and the railroads which have operated them are ordering more, which is evidence that the results obtained must be satisfactory.

It is pleasing to state that, as we become more familiar with the use of the superheater the troubles are growing considerably less. The principal causes of the troubles are: First, differences in temperature expansions; second, lack of sustained or proper supports by liberal sized bands and supporting rests, to avoid vibrations and prevent wearing holes in the flues; third, use of improper materials for joint bolts, or bolts severely overstrained in the application of the units: fourth, construction or use of improper materials for return bends; fifth, abuse of the device by improper handling.

The following causes of loss of efficiency occur:

Dirty Surfaces.—The superheater should be accessible for easy cleaning, as in the roundhouse it is very important to have the flues and superheater surfaces blown clean of ashy deposits.

Leakages of Steam.—At all indications of leaks hydrostatic tests should be applied, as it is very necessary to keep the superheater free from leaks.

Improper Damper Adjustments.—Unless the dampers are so adjusted that they can open properly under automatic control, proper flow of the gases through the superheater tubes is not secured, and a great loss in efficiency is sustained.

Maintenance of a Proper Water Level.—A too high water level in the boiler causes the steam to carry much water over into the superheater. This may be due also to dirty water conditions, and it would appear that maximum superheat cannot be obtained except under clean water conditions, and insistence on the engineman carrying his water at the proper levels, generally as low as safe operating conditions will warrant, is necessary.

Improper Firing.—Firing must be very carefully done, as, when a fire is too thin, excess air will result in the cooling of the superheater tubes, and a heavy and smoky fire will smudge them and interfere with obtaining high superheat temperatures.

It is not sufficient to have lubricators which work uniformly, but drifting steam must be used under automatic control. Results without drifting steam are generally unsatisfactory. This manifests itself in carbonization of the lubricants, excessive wear of surfaces, broken packing rings, and high wear and destruction of rod packings. With drifting steam, and preferably on piston valve engines, some by-pass valve arrangement should be used, as then these conditions are generally overcome and a condition bordering on saturated steam operation can be obtained. With the solution of this problem high superheat temperature, with its greater economies, is obtainable.

It would appear that no perceptible saving is realized with less than 100 degrees of superheat, while over this the savings increase rapidly. The reason for this is that superheated steam cannot be depended upon to be dry below 570 deg. F. terminal temperatures, and as long as any suspended vapor is contained in the superheated steam, condensation will speedily follow. From this it is apparent we must come to the use of higher degrees of superheat. To get this we may need more superheat units, and may have to adopt some more efficient way of superheating, and with it may come types requiring longer boilers, with increased diameters, and longer lengths of flues.

The superheater in its present form is very sensitive. Perhaps as we understand it in its present state of development, it may be too sensitive, but with proper handling and maintenance it is giving very satisfactory results. But it is very important from its extreme sensitiveness that the throttle valve should be opened gradually at starting and kept in such a position that there is a pressure drop at the steam chest of from five to seven pounds below the boiler pressure, as unless this is done we cannot be sure of getting dry steam delivery into the cylinders.

For the proper determination of the amount of superheat in the steam the use of some instrument like the pyrometer is necessary when the more reliable records are required, although generally speaking, it is not necessary to know when a proper degree of superheat is obtained with the normal operation of the engine. This instrument, from general experience, would seem too complicated for roundhouse care and severe locomotive service when continuously used, but for short tests it serves the purpose very well. There is, however, need for a better and more reliable instrument.

The changes in locomotive practice and design during the past few years have been so rapid and revolutionary in character that it is difficult to even surmise what the next few years will develop. It is safe to say, however, that the superheater will at least remain a part of the locomotive, and in all probability have come to a higher state of development, and the point we must determine is this:

Is the type of superheater, so universally used, one which will endure, or is it apt to be superseded by a more durable and more efficient type?

DISCUSSION

B. B. Milner (N. Y. C.).—Quoting from a paragraph in the paper: "From this it is apparent we must come to the use of higher degrees of superheat"; I do not see that the fact that we must go to the use of higher degrees of superheat is proved by what precedes.

The broadest measure of efficiency in the operation of a locomotive is, as I see it, the coal consumption per unit of power developed; that is, the coal per horsepower hour. Whether that be drawbar or indicated horsepower is of no moment, since the difference between indicated horsepower and drawbar horsepower is not a function of superheat. This measure of ultimate efficiency in the operation of a locomotive as a power plant may be divided very logically into two sections: that pertaining to the boiler efficiency or to the boiler as an instrument for evaporating water, and that pertaining to cylinder efficiency, or to the cylinders as being instruments making use of the steam delivered to it by the boiler. In the boilers using superheaters of the type which is in general use in this country, we sacrifice, to some extent, evaporating heating surface. To some extent, perhaps not in direct proportion exactly, but to a certain extent, the provision of superheating surface reduces evaporating heating surface and, to somewhat less than that extent perhaps, I should not say proportionately, you are reducing the efficiency of your boiler as a water evaporator when you dispense with evaporating heating surface by the application of a superheater of the fire-tube type.

Cylinder performance is materially increased by the use of the superheated steam. That increase may be studied by division or separation of the losses which usually occur in saturated steam cylinder operation. First of all and most important, is that due to the initial condensation. The steam in a saturated locomotive is part water before it gets to the piston and the significance of the initial condensation losses

may perhaps be made very apparent when I quote a few percentages from data from some of Professor Goss's investigations made in a long series of tests at the Purdue University testing plant and appearing in his work on Locomotive Operation. He therein presents tables showing the percentage of steam accounted for by the indicator card, at a series of cut-offs and for a series of speeds. I shall read for 25 per cent cut-off at speeds increasing by increments of 10 miles an hour from 15 miles an hour—72 per cent, 76 per cent, 80 per cent, 79 per cent, 80 per cent. The minimum amount of steam accounted for, therefore, is 72 per cent, while the maximum is 80 per cent. I only want to bring home to you the fact that the initial condensation losses in a saturated engine are very significant, at least 20 per cent, according to these figures, and as high as 28 per cent. The use of properly superheated steam eliminates that loss.

There must be a limit to the amount of superheat we can use economically and to the distance which we can travel on the road of increasing superheated steam temperatures. With our present type of superheater it means that we will put in more superheater units. Imagine for the moment, doubling the number of units which you are using in some of your modern engines and you will appreciate that the efficiency of the boiler as a water evaporator will at some point be reduced to a point where you will not be able to get enough water from your boiler to keep going. On the one hand you have the counteracting increased cylinder efficiencies resulting from the introduction of superheat, but at some point in traveling the road of higher and higher superheat temperatures, your curve of combined cylinder and boiler efficiency will begin the downward trend as you approach the conditions of excessive superheat which I have just pictured. Now, somewhere between those two extremes is the superheat temperature, representing the condition of superheating capacity which will give us the maximum of combined efficiency; I mean the combination of the boiler efficiency and the cylinder efficiency.

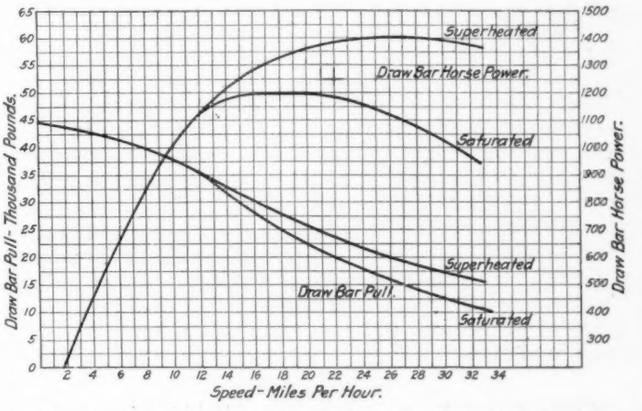
Imagine for the moment, a simple locomotive of superheating capacity sufficient to give a total temperature of say 650 deg. Imagine that the engine is operating under usual running conditions and that steam is entering the cylinders at 650 deg. Then, for the moment, speculate upon what may be the temperature of the steam that is going from the exhaust. I surmise that the steam which is actually coming out of the exhaust is much above saturated steam temperatures. To the extent that the total of heat leaving the stack has been increased, the provision of superheat represents a loss.

I do not want to suggest that I do not believe in the superheating of steam. I do. But I am wondering if we had not better at this time take some inventory of what we now have and speculate very carefully upon the question of whether we have yet reached the amount of superheat which will give us maximum efficiencies; particularly in view of the maintenance difficulties, the increased maintenance expenses, which are already very real, and must materially increase if we increase the steam temperatures we use.

G. E. Ryder (Locomotive Superheater Co.).—In speaking of superheating existing engines, the author has rightly stated that the conversion problem involves a careful consideration of local conditions. The cost of conversion, equated against the results that are to be obtained, is the final deciding factor which determines whether or not the investment is to be justified. While this consideration is applicable to concrete problems, the effect that superheating will have on the operation of the locomotive, the saving in fuel, and the increased hauling capacity are established and will apply in general to any type or class of locomotive under consideration.

A study of pull-speed curves mentioned by the author invariably shows practically coincident figures for drawbar horsepower and drawbar pull for both saturated and superheated locomotives from starting to about ten or twelve miles per hour. From this speed on through higher speed the superiority of the superheater locomotive is apparent and the gain in drawbar horsepower with the consequent tractive power increase is realized. The maximum capacity of the saturated engine is much lower than that of the superheater locomotive and is reached at a much slower speed. It will be noted that the capacity also falls away much more rapidly in the case of the saturated locomotive.

The difference between the curves of drawbar horsepower or drawbar pull, which is, of course, tractive power, at any given speed represents the gain in locomotive capacity at that speed which is realized by superheating. As an illustration, let us refer to the accompanying pull-speed curve, which is characteristic, and taken from the result of tests of maximum capacity at increasing speeds of consolidation locomotives identical with the exception that one is equipped with the superheater and one is not. The superheater locomotive, at a speed of 30 miles per hour, is developing 350 to 400 more horsepower which is available as increased drawbar pull or tractive effort. This amounts to 5,000 lb. and repre-



Speed-Pull Curves for Saturated and Superheated Steam Locomotives

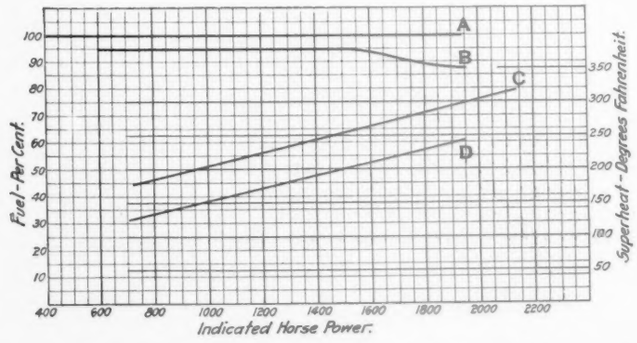
sents a net gain in locomotive capacity obtained by the application of the superheater. Reducing this to a unit basis, in order to compare this cost with the cost of obtaining increased tractive power from other sources, it is found that in applying superheater to an existing piston valve engine at a cost of approximately $1,700, increased tractive effort may be obtained at a cost of about 40 cents per lb. The application of a superheater to a slide valve engine, necessitating a change to piston valves, increases the first cost to about $2,500, and represents the purchase of increased tractive effort at about 55 cents per lb. These figures are computed from results obtained at a speed of 30 miles per hour, and when used for comparison should be compared on the same basis.

H. B. Oatley (Locomotive Superheater Company).—It is evident from Mr. Milner's remarks that he has been thinking somewhat along the same lines as many of us who have been particularly interested in the development of the superheater. With some of his statements I can agree, but with some of the conclusions which he has reached I feel compelled to differ.

In the first paragraph of the paper, the question of the degree of superheat is briefly referred to. I think the writer of the paper and the speaker are in accord as to the basic principles of superheated steam and its application and that I may, without giving offense, differ slightly from him on the question of the amount of superheat and the relative importance of its advantages. It *is* true that superheated steam is the only medium by which cylinder condensation can be entirely eliminated, but I do not feel that the elimination of

condensation losses is a measure of the amount of superheat to be advantageously employed. I think that in superheated steam the increased volume per unit of weight, together with its increased fluidity, is an advantage which is on a par, at least, with the elimination of condensation.

Under the heading of the use of higher superheat temperatures, Mr. Riegel has touched upon a phase of the subject which has been very prominent in the minds of all who have been looking into the future. There is practically no limit to the temperature that can be given to the steam in the steam chest, whenever railroad organizations are ready to still further increase the efficiency and capacity of their locomotives. It is more than probable that the present type of the fire tube superheater will undergo modifications, as we are called upon to deliver steam at higher temperatures, although the present type "A" superheater has a considerable margin in this respect that has not yet been utilized. I presume that the railroad with which Mr. Riegel is connected is using a higher average steam temperature on its locomotives, than any other road in this country. This is due to several causes, among which are the kind of fuel, severe operating conditions, and last, but not least, appreciation on the part of the motive power department of the Lackawanna, of the advantages of the higher steam temperatures. I presume that if you were to ask Mr. Riegel to be allowed to take out a few units from his Pacific engine, you would "start something." I feel very positive about this, because I asked the question of other railroad men and found them unwilling to reduce steam temperatures. There are, of course, various ways of looking at the question of increased amount of superheat and I find one point of view that is occasionally encountered, which hinges on the fact that superheat is present in the exhaust and that an increase in the initial superheat will increase the exhaust temperatures. This has seemed to the minds of a few as spelling "loss" rather than "gain." When it is considered that the increase in volume of the steam by superheating is extremely rapid, and that this increase in volume per unit of weight



Curves Showing Fuel Reduction in Per Cent Due to An Increase in Superheat; Engine with Superheat as Shown in Curve D Used as a Base

means a reduction in the weight of steam used per revolution, and when we further consider that the increased heat content is very slight in comparison with the increase in volume, it will be evident that the amount of steam used and, therefore, the amount of coal burned will be decreased as we increase the initial superheat. The fact that the exhaust is at a slightly increased temperature will not be a source of loss. Another fact that must not be lost sight of is that with the increased initial steam temperatures, there is a decrease in the back pressure in the cylinder. This has been very pronounced in superheater engines which are now running, and it will be even further decreased as we increase steam chest temperatures still further.

Some very interesting data on this point has recently been obtained and is impressive in demonstrating the advantages of increased temperature. The diagram shows the reduction in fuel consumed, obtained by an increase of 50 deg. in the superheat. Two series of tests were conducted on engines of identical size and weight, and with boilers of identical size, the difference being in the temperature of the steam at the steam chest. The upper line marked *A* is given a value of 100 per cent, and represents the fuel consumption of the engine with the lower superheat. The line marked *B* shows the relative fuel consumption of the engine which had the 50 deg. increase in superheat. It was found that the higher superheat engine used only about 94 per cent as much fuel as the other engine, up to an output of about 1,550 horsepower. Above this rate of working the fuel consumption dropped until at the limiting output of the lower superheat engine, the fuel consumption was only 87 per cent and, furthermore, the higher superheat engine gave an output of about 200 indicated horsepower more than the lower superheat engine. I can appreciate that the talk of fuel economies of from 6 per cent to 13 per cent does not sound very big in this present day and age, but the figures given represent economies obtainable over present superheater engines by an increase of but 50 deg. in steam temperature.

It would seem to me that in the paper there has been a misprint and that the steam temperature mentioned should have read 470 deg. instead of 570 deg. I feel quite sure that in locomotive practice, at least with steam superheated in the fire-tube type of apparatus, providing for a thorough mixing of the steam, that above a temperature of about 500 deg. F., there would be no suspended moisture present. My opinion in this matter in no way affects my endorsement of Mr. Riegel's statement that we must come to the use of higher degrees of superheat. To get this higher degree of superheat, the present form of apparatus, as referred to some few minutes ago, has possibilities that have not yet been exhausted. This limit of the present type "A" apparatus is somewhat variable and depends, to a great degree, on the size and shape of the boilers to be dealt with. We have developed and experimented somewhat with a modification of the standard fire-tube superheater, known as the type "E." Practically any degree of superheat, within reason, can be developed with this design. It can be fitted in a boiler so as to provide increased power output over the standard, or type "A." It is my firm belief that future development of the superheater will be along some such lines. The final paragraph of Mr. Riegel's paper I would personally interpret as referring to some such development as I have just described. To me it suggests a *development* of the fire-tube type rather than a suggestion of a *different* type, which would, by many, be interpreted as referring to a barrel type or a front end superheater, or some design other than the fire-tube construction.

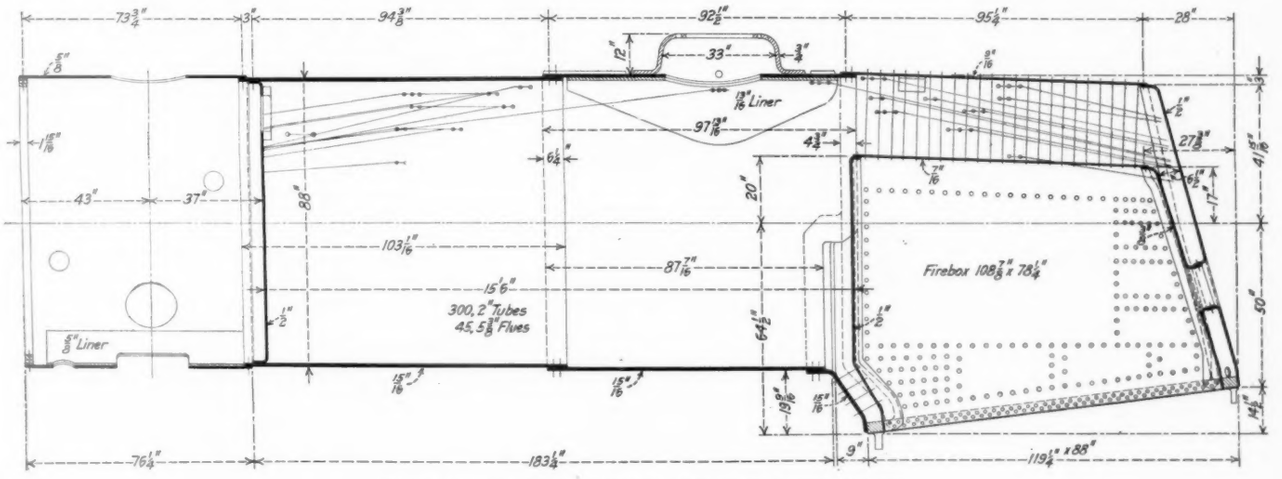
The question of lubrication is something that we have had to study, and I believe it may be fairly said that the difficulties in going from saturated steam to 200 deg. of superheated steam have been overcome. The step made thus far has been a greater one than the step from 200 to 300 deg., or even 350 deg. of superheat.

PREPARING IRON FOR MALLEABLE CASTINGS.—The iron for malleable castings is almost always melted in the air furnace or small openhearth furnace, as it has been found that the cupola cannot be depended upon to give metal of sufficient uniformity to insure successful malleableizing. The composition of the metal has to be kept within quite close limits, which vary in accordance with the size of the castings being made, and the manufacturer has to exercise much skill and ingenuity in designing his patterns and molds. The castings are packed in iron boxes, which are heated to a red heat in annealing furnaces of the ordinary type. They are annealed for several days, and test bars or castings in each box are tested in order to be sure that the process has been properly performed.—*American Machinist.*

LARGE CONSOLIDATION LOCOMOTIVE

Designed for Use in Ore Traffic on the Lake Superior & Ishpeming; the Total Weight is 268,000 lb.

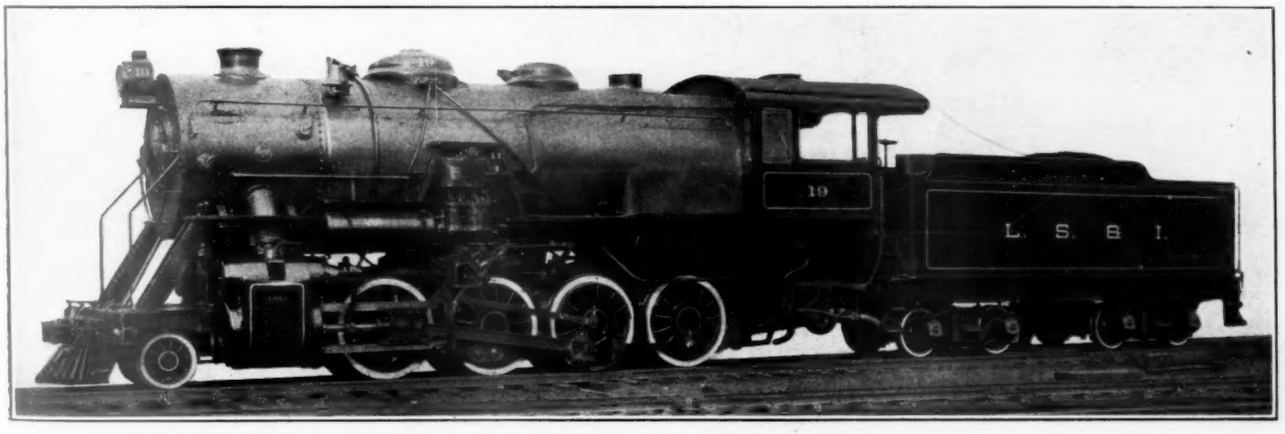
Three large Consolidation type locomotives, developing a tractive effort of 55,900 lb., have recentiy been built for the Lake Superior & Ishpeming by the Baldwin Locomotive Works. These locomotives will be used for ore traffic, their most exacting service being to haul trains of empty steel cars up a grade of 1.63 per cent, combined with curves of 5 deg. The question as to whether Consolidation or Mikado type locomotives should be built for this service was carefully considered and it was decided that, as the run is made at comparatively slow speed, the Consolidation type would be fully capable of meeting the requirements. Furthermore, the Consolidation could be designed with a total wheel base of the engine and tender to suit the turntables, which have a length of 65 ft. A fourth locomotive, similar in all respects to those referred to above, has been built for the Munising, Marquette & Southeastern.



Boiler of the Lake Superior & Ishpeming Consolidation

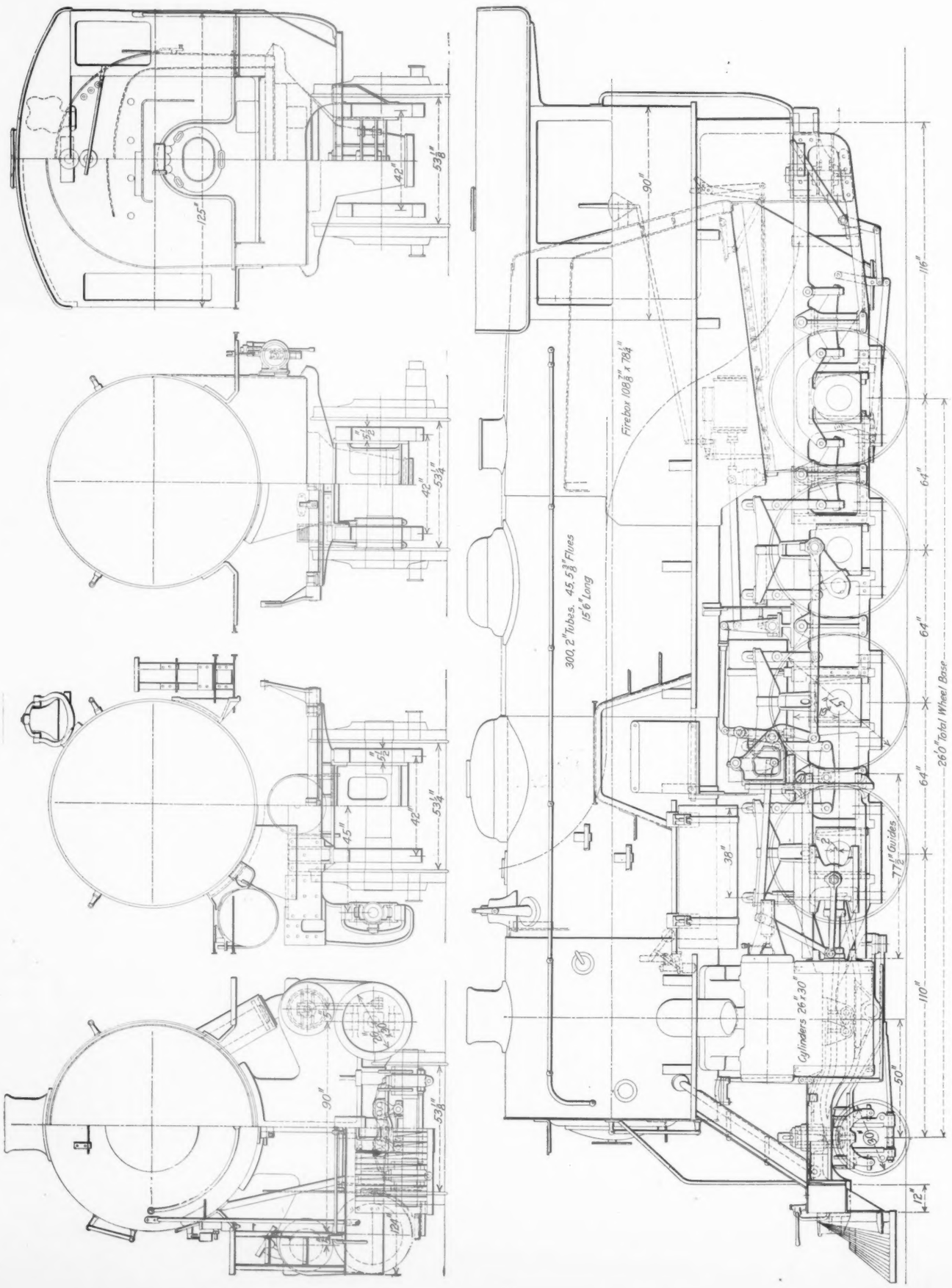
The boiler used in this design is of the straight top type, with sloping roof, throat and backhead. The center line is placed 10 ft. 4 in. above the rail, and by sloping the mud ring toward the front there is room for a throat 19 9/16 in. deep. The furnace contains a Security sectional arch, supported on four water tubes. The dome is of pressed steel, measuring 33 in. in diameter and 12 in. in height. It contains a throttle valve of the improved Rushton type, with drifting valve. The vertical throttle pipe is flattened in cross-section, and placed sufficiently far forward in the dome to enable a man to enter the boiler without dismantling the throttle valve and its connections. The longitudinal boiler seams have a strength equal to 90 per cent of the solid plate. The seam on the dome ring is welded throughout its length on either side of the dome opening. The injector check is placed on the top center line, and the seam on the first ring is welded on either side of the check hole, and this seam is also welded at the ends. The front end of the firebox crown sheet is supported by three rows of Baldwin expansion stays.

This boiler is of unusually high capacity for a Consolidation type engine. It contains a 45-element superheater, which provides a heating surface of 844 sq. ft., and the total equivalent heating surface, assuming each square foot of superheating surface as equivalent to 1½ sq. ft. of evaporative heating surface, is 4,909 sq. ft.



Heavy Consolidation for the Lake Superior & Ishpeming

The cylinders and steam chests are lined with bushings of Hunt-Spiller gun iron, and the same material is used for

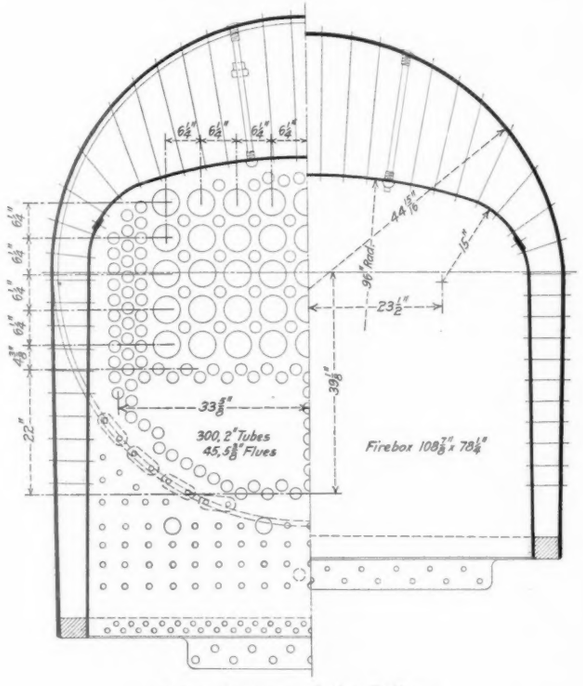


General Arrangement of the Lake Superior & Ishpeming Consolidation Type Locomotive

the piston and valve packing rings. The Nathan automatic vacuum breaker is applied. The valve motion is of the Baker type, and the gears are controlled by the Ragonnet power reverse mechanism which in this case can be operated by either compressed air or steam. The valve motion bearers are supported on the guide yoke. The crosshead link is attached directly to the crosshead wrist pin, thus saving weight and simplifying the design.

Each main frame is cast in one piece with a single front rail, and has a width throughout of 5½ in. The transverse frame braces include a large steel casting which supports the front end of the firebox, and is extended forward to brace the main driving pedestals. The brake cylinders are supported on the main frames, just forward of the leading driving pedestals. The brake shaft is fulcrumed on two steel castings which are bolted to the frames under the cylinder saddle. These castings also serve to support the engine truck radius-bar crosstie.

The tender frame longitudinal sills consist of 13-in. steel channels. The tank is of the water bottom type, with a capacity for 8,500 U. S. gal. of water and 13 tons of coal.



Cross Sections of the Boiler

These locomotives rank among the largest of the Consolidation type thus far constructed, and probably represent the maximum capacity obtainable in this type with the weight and clearance limitations imposed.

The following are the principal dimensions and data:

General Data

Gage	4 ft. 8½ in.
Service	Freight
Fuel	Bit. coal
Tractive effort	55,900 lb.
Weight in working order	268,000 lb.
Weight on drivers	238,000 lb.
Weight on leading truck	30,000 lb.
Weight of engine and tender in working order	425,000 lb.
Wheel base, driving	16 ft. 0 in.
Wheel base, total	26 ft. 0 in.
Wheel base, engine and tender	60 ft. 11½ in.

Ratios

Weight on drivers ÷ tractive effort	4.26
Total weight ÷ tractive effort	4.80
Tractive effort × diam. drivers ÷ equivalent heating surface*	650.00
Equivalent heating surface* ÷ grate area	85.20
Firebox heating surface ÷ equivalent heating surface,* per cent	4.40
Weight on drivers ÷ equivalent heating surface*	48.40
Total weight ÷ equivalent heating surface*	54.60
Volume both cylinders	18.50 cu. ft.
Equivalent heating surface* ÷ vol. cylinders	265.00
Grate area ÷ vol. cylinders	3.43

Cylinders

Kind	Simple
Diameter and stroke	26 in. by 30 in.

Valves

Kind	Piston
Diameter	14 in.

Wheels

Driving, diameter over tires	57 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	11 in. by 13 in.
Engine truck wheels, diameter	30 in.
Engine truck, journals	6½ in. by 12 in.

Boiler

Style	Straight
Working pressure	185 lb. per sq. in.
Outside diameter of first ring	88 in.
Firebox, length and width	108⅞ in. by 78¼ in.
Firebox plates, thickness, sides and back, ⅜ in.; crown, 7/16 in.; tube, ½ in	
Firebox, water space	Front, 5 in.; sides and back, 4½ in.
Tubes, number and outside diameter	300—2 in.
Flues, number and outside diameter	45—5⅜ in.
Tubes and flues, length	15 ft. 6 in.
Heating surface, tubes and flues	3,398 sq. ft.
Heating surface, firebox	216 sq. ft.
Heating surface, arch tubes	29 sq. ft.
Heating surface, total	3,643 sq. ft.
Superheater heating surface	844 sq. ft.
Equivalent heating surface*	4,909 sq. ft.
Grate area	57.7 sq. ft.

Tender

Weight	157,000 lb.
Wheels, diameter	33 in.
Journals, diameter and length	6 in. by 11 in.
Water capacity	8,500 gal.
Coal capacity	13 tons

*Equivalent heating surface = total evaporative heating surface + 1.5 times the superheating surface.

INTERESTING FACTS CONCERNING GRADE RESISTANCE AND CAR FRICTION

BY HUGH G. BOUTELL

While making a number of dynamometer car tests to establish satisfactory tonnage ratings on a certain railroad, two curious facts were brought out.

In the first place, it was determined that on at least one division of the road the ruling grade was not the same for all trains. It was somewhat of a surprise when a short train was taken out for a test run and was nearly stalled on a grade where only a moderate drawbar pull showed on the dynamometer record for the previous test of the long train. In fact, the grade was not considered as the ruling grade of the division at all.

For a time those in charge were at a loss to account for this, particularly as the grade in question was a very short one, and seemed insignificant compared with the so-called ruling grade several miles long at another point. In this very fact, however, was found the explanation. It was actually shorter than the long train and just a little longer than the short train. In the first case only about half the train was on the hill at one time, the remaining portion being on the level track at each end. Therefore the locomotive had only to lift one-half the train up the grade at one time, while with the short train all the weight had to be lifted at once. Upon investigation it was found that this little hill really was a grade of about one per cent. Of course, if this grade had been so located that the train could take it at comparatively high speed it would have had but little effect on the drawbar pull, but the conditions in this case compelled the train to approach slowly through a town.

The second point noted during the tests was that the resistance of a given car varies to a considerable extent, depending upon the character and distribution of the load in the car. It was proved quite conclusively that a 50-ton gondola car loaded to capacity with coal is easier to haul than the same car loaded with rock. As a general thing on a road with a large number of curves, the higher the center of gravity of the load, the easier the car seems to be to haul. Car equipment used in the transportation of crushed rock for ballast is notoriously hard to haul, the reason usually given being the poor condition of this equipment, but it is probable that the low center of gravity of the load is often responsible

EXAMPLES OF RECENT LOCOMOTIVES OF THE MOUNTAIN, PACIFIC, TEN-WHEEL, MOGUL AND SWITCHING TYPES

ARRANGED IN ORDER OF TOTAL WEIGHT

Type	4-8-2	4-8-2	4-6-2	4-6-2	4-6-2	4-6-2	4-6-2	4-6-2	4-6-2	4-6-2	4-6-0	4-6-0	2-6-0	0-8-0	0-8-0	0-6-0	0-6-0	0-6-0
Name of road	N.&W.	Can. Pac.	P.R.R.	D.L.&W.	R.F.&P.	A.T.&S.F.	M.K.&T.	C.B.&Q.	G.N.	N.C.&St.L.	G.S.&F.	Cent.Ver.	N.&S.S.	N.Y.C.	L.&N.E.	M.Cent.	M.St.P. & S.S.M.	C.G.W.
Road number or class	K1	2900	K4s	1131	2	3600	378	2951	1461	506	179	218	31	4299	115	167	345	465
Builder	R.R.Co.	R.R.Co.	R.R.Co.	Amer.	Baldwin	Baldwin	Amer.	Baldwin	Lima	Baldwin	Baldwin	Amer.	Baldwin	Amer.	Baldwin	Amer.	Amer.	Baldwin
When built	1916	1915	1914	1915	1915	1914	1915	1915	1914	1915	1914	1915	1915	1914	1915	1915	1915	1915
Tractive effort, lb.	57,200	42,900	41,850	47,500	47,400	41,000	40,700	42,000	40,500	33,500	31,500	27,600	39,500	49,500	44,500	37,000	31,200	35,000
Weight, total, lb.	341,000	286,000	308,900	305,500	293,000	288,700	272,000	266,400	251,200	219,550	192,250	189,000	185,500	239,500	207,850	165,000	151,000	148,200
Weight on drivers, lb.	236,000	192,000	201,800	197,300	188,000	172,550	165,000	169,700	150,700	143,500	147,200	141,000	163,800	239,500	207,850	165,000	151,000	148,200
Weight on leading truck, lb.	50,000	53,000	53,600	52,200	53,000	59,950	54,000	47,800	55,000	37,400	45,050	48,000	21,700	.....	.....	.....	.....	.....
Weight on trailing truck, lb.	55,000	41,000	53,500	56,000	42,000	56,200	53,000	48,900	52,700	38,650	.....	.....	.....	.....	.....	.....	.....	.....
Weight of tender, loaded, lb.	146,700	157,000	158,000	165,800	179,000	217,300	160,000	158,600	168,800	155,450	147,750	139,000	99,500	148,300	152,150	126,000	102,900	116,800
Wheel base, driving, ft. & in.	18—9	18—3	13—10	13—0	13—0	13—8	13—0	13—0	13—0	13—0	15—0	15—6	11—6	16—0	14—3	11—6	11—6	11—6
Wheel base, total engine, ft. & in.	40—5	39—6	36—6	34—5	34—1	35—3	34—4	33—8½	33—9	34—1	25—11½	27—4	20—0	16—0	14—3	11—6	11—6	11—6
Wheel base, engine and tender, ft. & in.	72—11	66—6	71—10	67—1	72—4	71—5¼	69—4½	65—10¾	66—9	69—4	61—4	58—9¾	50—5½	53—8½	49—8	48—7¾	43—8	44—1¼
Diameter of drivers, in.	70	70	80	73	68	73	73	74	73	69	68	69	52	58	50	51	51	51
Cylinders, number	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Cylinders, diameter, in.	29	23½	27	27	26	26	25	27	23½	23	21	20	23	25	22	21	20	21
Cylinders, stroke, in.	28	32	28	28	28	26	28	28	30	28	28	28	26	30	28	28	26	26
Valve gear, type	Baker	Wals.	Wals.	Wals.	Baker	Baker	Baker	Wals.	Wals.	Wals.	Southern	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.
Steam pressure, lb.	200	200	205	200	200	200	200	180	210	185	200	200	180	180	200	180	180	185
Boiler, type	Conical	E.W.T.	Belpaire	E.W.T.	W.T.	W.T.	W.T.	E.W.T.	Str. Belp.	W.T.	W.T.	...	Straight	E.W.T.	Wootten, Str.	Str.	E.W.T.	Straight
Boiler, smallest outside diameter, in.	80½	72	78½	79½	80	80	75¼	78	72	66	67¼	64¼	80	72⅛	74	66	65	68
Tubes, number and diameter in inches.	233—2	210—2¼	237—2¼	272—2	230—2¼	244—2¼	284—2	200—2¼	155—2¼	186—2	199—2	175—2	241—2	214—2	177—2	163—2	168—2	171—2
Flues, number and diameter in inches.	36—5⅜	30—5¼	40—5½	38—5⅜	40—5½	40—5½	36—5⅜	34—5½	32—5½	24—5⅜	26—5½	24—5⅜	36—5½	30—5½	26—5½	22—5½	26—5½	24—5½
Length of tubes and flues, ft. & in.	21	20—7⅜	19—0	17—0	20—6	21—0	20—0	18—6	21—0	20—6	15—0	15—0	12—0	16—6	14—4	16—0	11—0	11—6
Heating surface, tubes and flues, sq. ft.	3,607	3,402	3,746	3,311	3,942	4,211	3,593	3,072	2,870	2,678	2,100	1,869	2,066	2,547	1,854	1,862	1,367.6	1,416
Heating surface, firebox, sq. ft.	374†	265	288.6	369†	263†	232	245†	292†	206	213†	168	184†	190†	204†	220	139†	178.4	163†
Heating surface, total, sq. ft.	3,984	3,667	4,035.4	3,680	4,205	4,443	3,838	3,364	3,076	2,891	2,268	2,053	2,256	2,751	2,074	2,001	1,546	1,579
Heating surface, superheater, sq. ft.	882	760	1,153.9	760	975	980	870	751	640	592	462	403.5	494	579	443	403	311.2	299
Heating surface, equivalent*, sq. ft.	5,304	4,807	5,766.3	4,820	5,667	5,913	5,143	4,490.5	4,036	3,779	2,961	2,658.2	2,997	3,330	2,738	2,605	2,012	2,027
Grate area, sq. ft.	80.3	59.6	70	91.3	66.7	66.7	57.5	58.7	53.3	52.4	49	53.4	50	53.3	95	32.6	31	32.5
Firebox, length, in.	120⅛	161½	126	126	114½	114	115	108¼	116	114	107⅛	102⅛	96¼	102	126⅛	72⅛	108⅛	102
Firebox, width, in.	96¼	89	80	104¼	84¼	84¼	72	78¾	66¼	66	66	75¼	75⅛	75¾	108¼	65¼	41¼	66
Kind of fuel	Bit. coal	Bit. coal	Bit. coal	Anth. coal	Bit. coal	Oil	Bit. coal	Bit. coal	Bit coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. & Anth.	Bit. coal	Bit. coal	Bit. coal
Tender, fuel capacity, tons or gallons	14	12	12½	10	15	3,300	12½	13	15	14	12	12	12	14	14	10	8	8
Tender, water capacity, gal.	9,000	7,200	7,000	9,000	10,000	10,000	8,000	8,200	8,000	8,500	7,500	7,000	5,000	7,500	8,000	6,000	5,000	6,000
Weight on drivers ÷ tractive effort.	4.1	4.5	4.8	4.1	3.9	4.2	4.0	4.0	3.5	4.3	4.7	5.1	4.1	4.8	4.7	4.5	4.8	4.2
Total weight ÷ tractive effort.	5.9	6.6	7.3	6.4	6.2	7.0	6.7	6.3	6.1	6.6	6.1	6.8	4.7	4.8	4.7	4.5	4.8	4.2
Tractive effort × diam. drivers ÷ equivalent heating surface*	753.0	625.0	580.6	719.4	569.0	637.2	577.0	693.0	733.0	611.0	723.4	715.0	769.0	862.2	813.0	725.0	791.0	880.0
Equivalent heating surface* ÷ grate area	66.1	80.7	82.3	52.8	85.0	88.5	89.5	76.4	75.7	72.2	60.4	49.7	60.0	62.5	28.8	79.8	64.9	62.2
Firebox heating surface ÷ equivalent heating surface*, per cent	7.1	5.5	5.0	7.7	4.1	3.9	4.8	6.5	5.1	5.6	5.7	6.9	6.3	6.1	8.0	5.3	8.8	8.2
Weight on drivers ÷ equiv. heat. surface*.	44.5	39.9	34.9	40.9	33.2	29.2	32.1	37.8	35.3	38.0	49.7	53.0	54.6	72.0	76.0	63.5	75.2	73.1
Total weight ÷ equiv. heat. surface*.	64.4	59.5	53.7	63.4	51.7	48.9	52.8	59.5	62.0	58.1	65.0	71.1	61.9	72.0	76.0	63.5	75.2	73.1
Volume both cylinders	21.4	16.1	18.5	18.6	17.2	15.9	15.9	18.6	15.0	13.3	11.2	10.1	12.5	17.1	12.2	11.2	9.5	10.4
Equiv. heat. surface* ÷ vol. cylinders.	248.0	299.0	310.8	259.8	329.4	370.5	323.0	241.0	268.0	284.0	264.0	262.5	240.0	195.0	224.0	232.0	212.0	194.9
Grate area ÷ vol. cylinders.	3.7	3.7	3.7	4.9	3.9	4.2	3.6	3.2	3.5	3.8	4.4	5.3	4.0	3.1	7.8	2.9	3.3	3.1
Reference to photographs, drawings or description	R.A.G.Apr. 1915-p799	R.A.G.M.E‡ 1915-p556	R.A.G.M.E.‡ 1914-p347	R.M.E. 1916-p4	R.M.E. 1916-p4	....	....	R.A.G.Aug. 1915-p275	R.A.G.Dec 1914-p1050	....	....	....	....	....	....	....	....	....

* Equivalent heating surface = total evaporative heating surface + 1.5 times the superheating surface. † Includes arch tube heating surface. ‡ *Railway Age Gazette, Mechanical Edition.*

Car Department

SUGGESTIONS FOR IMPROVEMENT IN CAR DESIGN

The following are the three prize-winning letters which were submitted in the contest on "How Can the Car Designer Improve?" This contest closed June 1, and the prizes were awarded on the basis of the practical suggestions offered.

BY C. H. FARIS

Scientific car designing is still in a crude state of development. Many attempts at scientific designing have been made and much "figgering" of cars has been done, but results have not been entirely satisfactory and no uniform practice or method has yet been developed that can be recognized as standard. Very little literature exists on the subject, and such as there is exists in the files of the different railway technical journals. Examination of these articles shows considerable variation in the methods and principles employed, and acquaintance with railway and car building drafting rooms also shows great differences in practice. Under such circumstances it is not surprising that "some classes of equipment spend too much time on the repair track," while "others may be too heavy in comparison with the revenue load which they will carry to be satisfactory to the operating department."

Improvement of the work of the car designer may be effected in two ways: first, in the improvement of the qualifications of the designer himself, and second, in the extension by comprehensive research of the knowledge of the principles and assumptions upon which such designing must be based.

The qualifications desired for a car designer are a sound and practical working knowledge of the subjects of mathematics, mechanics and strength of materials, good, commonsense judgment and enough shop and road experience to form a basis for the proper co-ordination of practical and theoretical knowledge. Persons having this desirable combination of qualifications are not abundant, but in most organizations there are men having the capacity for developing into first-class designers if means can be devised for their discovery, encouragement and training. The perfection by our industrial organizations of means for the scientific examination and classification of employees, according to fitness and capacity, will bring wonderful results.

Apart from the personal qualifications of the designer, there is need that the knowledge of principles, assumptions and methods of car designing should be extended and this knowledge formulated and made available for the car designer's use. Some good work of this kind has already been done. In 1896 a committee of the Master Car Builders' Association made a thorough investigation, both theoretical and experimental, of the design of axles, with the result that a method and formulas for this work were recommended to the association that have proved entirely satisfactory for the design of all car axles since that time. More recently, during the past two or three years, committees on car construction of this association have investigated the effects of buffing action on center sills of freight cars and have worked out methods of analysis that promise a complete solution of the problem of designing center sills for buffing stresses. The United States Post Office Department specifications for the construction of steel postal cars furnishes an outline of a method of procedure for the design of steel postal cars, the principles of which are largely applicable to the general design of steel passenger cars. These specifications represent the best and most authoritative statement of such principles available and are widely followed as a basis for passenger car design.

Further principles that need to be established as a guide for designing practice are: Satisfactory working stresses for sills and framing for freight cars; allowances to be made for oscillation and impact in calculating the stresses in these members; methods of combining the vertical loading stresses with the buffing stresses for center sills and the permissible values for these combined stresses. The post office specifications referred to above need amplification in some respects, especially in regard to the assumptions upon which the stresses in framing and load-carrying members are to be computed.

The research work necessary to extend our knowledge of the fundamental principles of car designing can be undertaken, the writer believes, by no one to better advantage than by the Master Car Builders' Association. No person or individual corporation can have such opportunities for collecting reports from all kinds of designs and for getting the records of the results of these designs in service as are afforded to committees of this association. The establishment of the further principles and methods needed to complete our data for car designing can be done in no more satisfactory way than that in which the principles and methods we use for axle and center sill designing have been established.

BY CHAS. E. WOOD
Foreman Freight Car Repairs, Union Pacific, Kansas City, Kan.

The steel freight car has passed through the experimental stage and is now a well-established feature of railroad equipment. But it is still in process of change and improvement. Lessons are being learned from the earlier cars which are proving a great help in the design of new equipment.

But the knowledge which has been gained through observation and careful noting of the defects which appear in the different designs of cars has not been obtained in the drawing office. The designer must depend on the information furnished him from the men in the field, and the repair forces should be encouraged at all times to report all failures which may occur, and to point out the weak features of any new design. This can best be accomplished by the systematic use of defective machinery sheets supplemented by a special report of any unusual condition which may be observed.

Even this is not sufficient to cover the ground thoroughly. There are any number of practical men who do not care to put their ideas in writing, thinking it might be construed that they are criticising their superior officers who are responsible for the design of equipment, but these men could be drawn out by a sympathetic and friendly talk with the car designer, and a closer and more personal relationship would work to a very great advantage. For instance, we

would suggest that whenever any cars of a new design are about to be built that a sample car first be built and then submitted to the inspection of a committee of car foremen with a view of locating possible weak points, or errors in the design. A few slight changes in the design before the cars are built might result in the saving of thousands of dollars. The car foreman knows from experience where to look for the weak points. He may not be able to figure out theoretically the reason for the weakness, but he will be able to refer you to equipment of similar design which has caused trouble.

It has been found that draft members composed of pressed steel shapes are inclined to buckle and break; also that they are very susceptible to corrosion. The pressed steel has been replaced by the solid cast steel on nearly all new cars. Even this material is liable to bend or fracture and too much reliance should not be placed on the steel castings without giving them the necessary diagonal braces to take care of the severe side thrust which they have to meet, for instance, when being coupled on curves.

One very important feature which appears to be overlooked by a great many designers is the facility for repairing damaged parts. The theory seems to exist that a car will run through its career and never need repairs. Unfortunately this is not the case, for it matters not how carefully designed, or how carefully constructed a car may be, it will, sooner or later, find itself on a repair track. The superstructure should be built on the steel underframe in such a manner that it can readily be removed and replaced to repair a damaged and twisted underframe without the necessity of destroying the siding or flooring of the car. This can now be done in some cases, but in others it is an impossibility and results in a very material increase in the cost of repairs. But the point which is most strikingly evident is the absolute lack of proper forethought in the design and application of safety appliances. In a great many cases it is impossible to apply a hand hold on a steel underframe without mutilating the car by chopping out the sub-sills because the hand hold was riveted to the steel sill before the wood parts were applied. This is avoidable and could be remedied by bolting the hand hold in place and allowing the bolts to pass through the wood sill. In fact, the advisability of riveting on any hand holds or sill steps is worthy of serious consideration. The rivets undoubtedly make a more secure fastening, but safety appliance defects, above all others, are the ones which we all strive to repair immediately on detection and on the old wooden cars or any place where the appliance is secured with bolts it is a comparatively simple operation. We cannot, however, expect our light repair men to carry a sledge hammer and cutting chisel to cut off rivets in the train yards, consequently we have to delay the car and contents while it is switched out and taken to a repair track to remedy these minor, but nevertheless important defects.

The use of special shaped ladder irons and hand holds should also be discouraged and the standard shapes adhered to so that an appliance can be renewed from regular stock without the necessity of having it made specially by the blacksmith. By the exercise of a little ingenuity on the part of the designer this could be done in most cases where now some odd design is used.

BY DENNISTOUN WOOD

There is but little question that the drafting room force on most of our roads is not in close enough touch with the repair men and those using the cars. In some cases the drafting room is located away from the shops and unless special effort is made the draftsmen seldom see the cars built from their designs, still less come in contact with those who use or repair them. When, as in most cases, the drafting room is adjacent to the general shops conditions are not as bad, although even then they are not as they should be.

Due to pressure of work the men are usually confined rather closely to the drafting table and seldom get out in the shop. Further, repair men, having about all they can do to attend to their regular duties, are not likely to go to the drafting room to point out weak points in design.

As a remedy the following suggestions are offered:

First.—The chief draftsman should make periodical visits to the various shops on the line, say to one shop each month. He will thus keep in touch with the repair work being done at the various points and will be able to select the best method of overcoming each class of trouble.

Second.—As opportunity arises in connection with problems of design, the draftsmen should be sent out to investigate, in preference to taking matters up by letter, thus keeping the entire drafting force in close touch with the maintenance situation.

Third.—When a new design is to be made, the drafting room should confer with the transportation department to learn its views as to the most suitable car for the service intended.

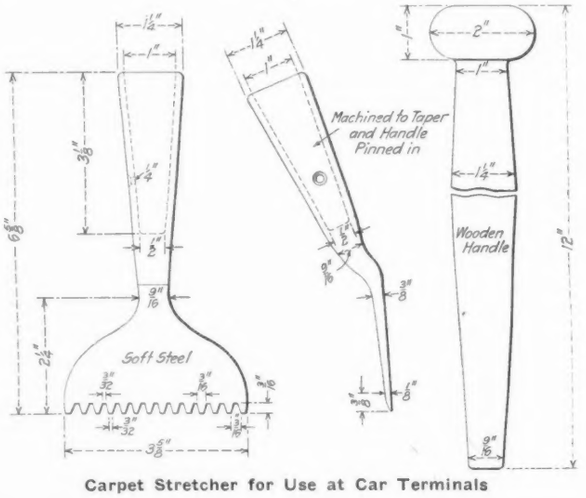
Fourth.—With the information gathered as outlined above, the new design can be worked out in a general way, but before finally being settled on prints should be sent to the different shop superintendents and general car foremen for criticism, as well as to the transportation department. When received, the criticisms can be weighed and the design altered to cover such of the points as appear to be well taken.

While this system will require more time for the final adoption of a design than were the draftsman to consult no one, it should result in a great saving in money, as the changes will be made on the drawing rather than on the cars after they are built, and in many cases will also mean the avoidance of damage claims chargeable to cars of improper design.

CARPET STRETCHER

BY C. C. LEECH

The accompanying engraving shows a simple design of carpet stretcher. The material of the toothed part and socket is soft steel and is forged out over the anvil, and a tapered steel pin may be used for forming the inside part of the socket for the handle. The toothed end is forged thin as shown and the teeth are easily laid out and filed in. No tempering is necessary and the whole forging may be rough

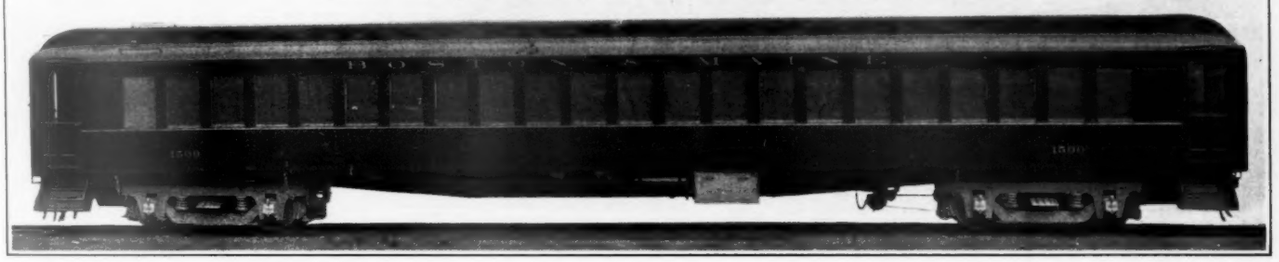


Carpet Stretcher for Use at Car Terminals

finished with a file, if desired, and painted with a coat of black enamel. The handle may be fashioned on any wood-turning lathe and should be of hard wood and shellaced. The dimensions given have been found to be about right.

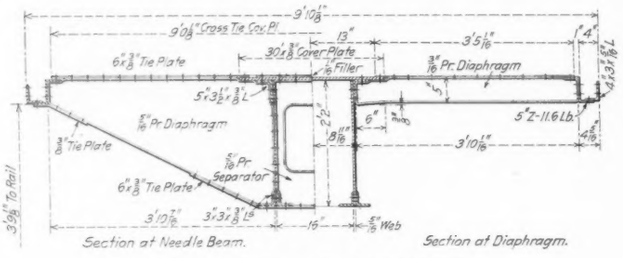
BOSTON & MAINE STEEL COACHES

First Steel Passenger Equipment to be Built for This Road Weighs 118,500 lb. and Seats 88 Passengers



Steel Day Coach for the Boston & Maine

The Boston & Maine recently received from the Pullman Company six steel coaches and two steel smoking cars which are the first passenger cars of this type of construction which this road has placed in service. The cars will be used in the through service between New York and Portland, Me., and

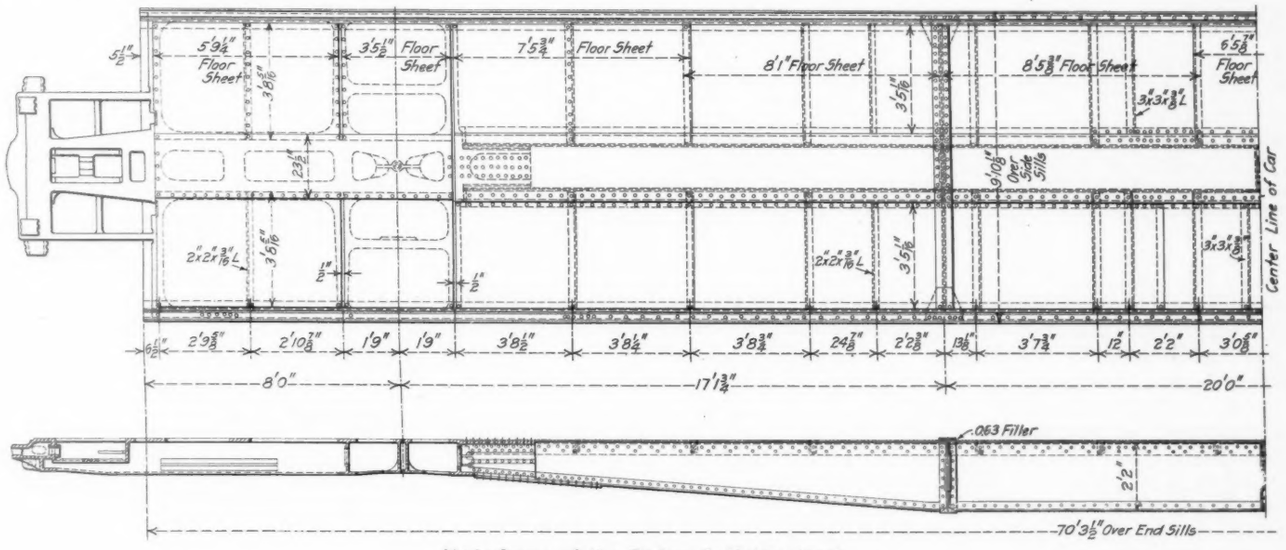


Cross Sections of the Underframe

will be followed by six 60-ft. baggage cars and two 70-ft. combination baggage and mail cars.

The new passenger cars are 70 ft. 3½ in. long over end sills, 80 ft. 3¾ in. long over buffer face plates and are mounted on 4-wheel trucks with 8-ft. wheelbase and spaced 54 ft. 3½ in. between center plates. Commonwealth cast steel platforms and double body bolsters are used with center sills of the fishbelly type. The center sills are built up of 5/16-in web plates with 5-in. by 3½-in. by ⅜-in. angles outside at the top and 3-in. by 3-in. by ⅜-in. angles inside and outside at the bottom. The sills are 26 in. deep at the deepest part and are spaced 16 in. apart and there is a 30-in. by ⅜-in. top cover plate extendir g between the bolsters. The side sills are made up of 5-in., 11.6-lb. Z-bars riveted to 4-in. by 3-in. by 5/16-in. angles and extending the full distance between the bolsters. The floor beams are 3/16-in. pressed diaphragms, 5 in. deep, and there are two crossbearers placed 10 ft. on either side of the center of the car and built up of 5/16-in. pressed diaphragms with 6-in. by ⅜-in. top cover plates extending across the car at the top and under the center sills at the bottom.

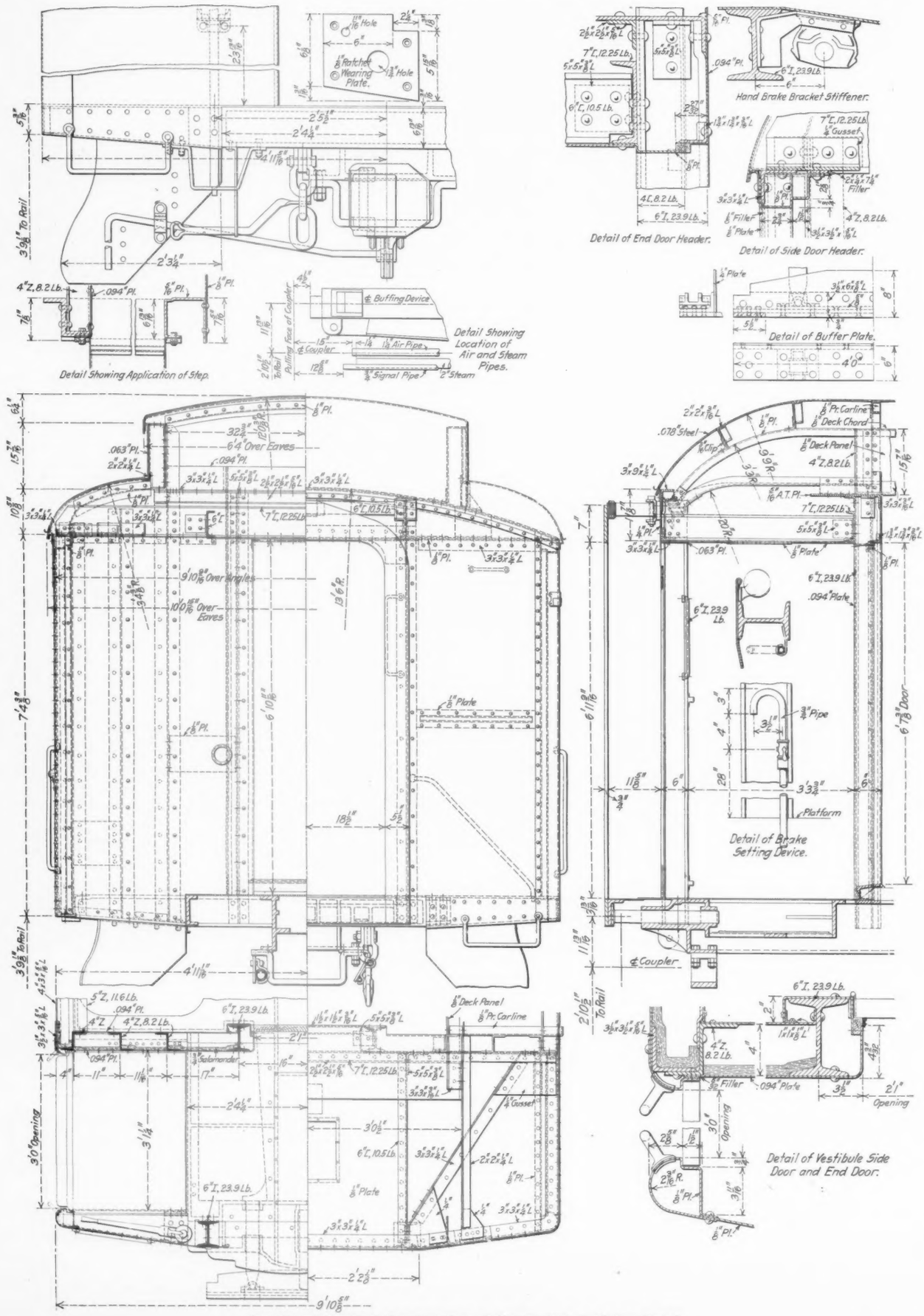
There is an anti-telescoping device which consists of two 6-in., 23.9-lb. I-beams at each end forming a part of the vestibule door post construction. In addition there are used in the body end construction a 3½-in. by 3-in. by 5/16-in. angle at the corner riveted to a 4-in., 8.25-lb. Z-bar, while there are two Z-bars of the same weight forming end posts between the door and corner posts. The door posts are 6-in., 23.9-lb. I-beams and the end plate is a 7-in., 12.25-lb. channel. The side frame construction includes a dropper bar as

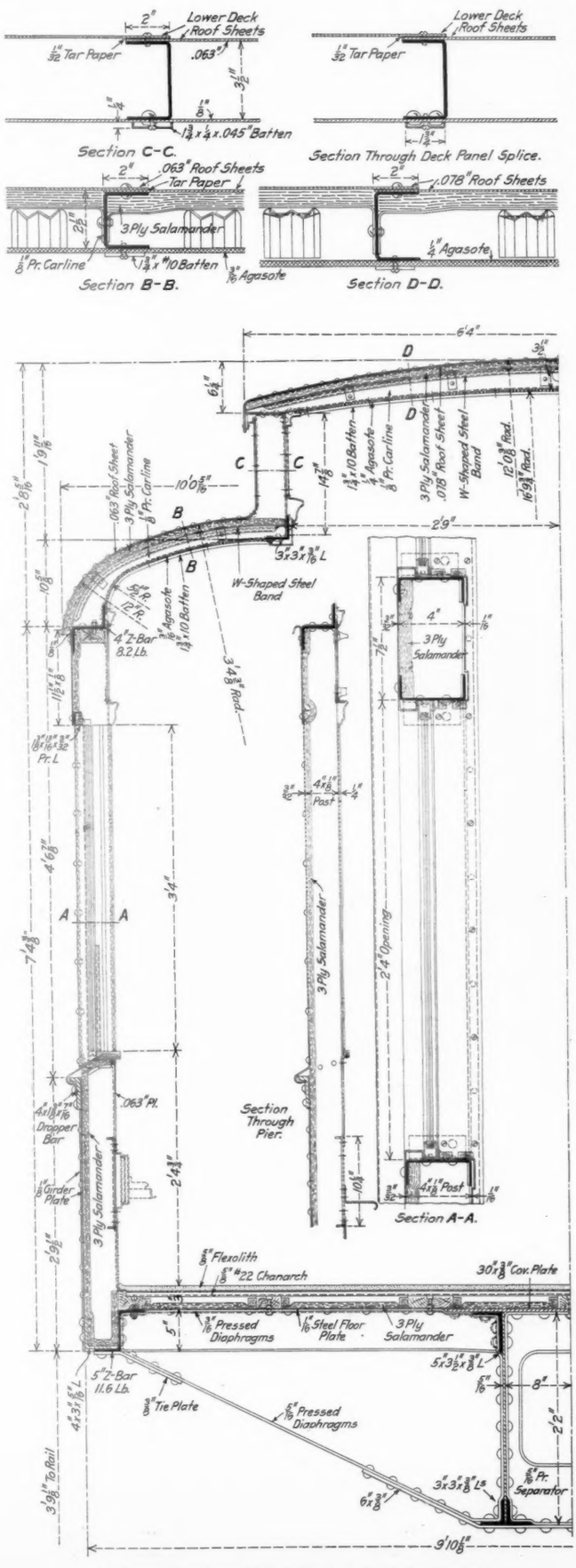


Underframe of the Boston & Maine Coach

belt rail, with 4-in. by ⅛-in. pressed channel side posts, two per pier.

The coaches weigh complete 118,500 lb. which gives a dead weight per passenger of 1,346 lb. The smoking cars


Detail Showing Application of Step.
Detail Showing Location of Air and Steam Pipes.
Detail of End Door Header.
Hand Brake Bracket Stiffener.
Detail of Side Door Header.
Detail of Buffer Plate.
Detail of Brake Setting Device.
Detail of Vestibule Side Door and End Door.
Details of the End Construction of the Boston & Maine Coach



Cross Sections of the Boston & Maine Coach

weigh 118,000 lb., the dead weight per passenger being 1,282 lb. The seating capacity of the coaches is 88 and that of the smoking car is 92; the latter have one saloon. The dead weight per passenger compares favorably with that of the composite underframe cars now in service on this road, this weight in these cars being 1,262 lb. The accompanying table shows a comparison between these cars and a number of other steel coaches:

	Total weight, lb.	Seating capacity	Weight per passenger, lb.	Length over end sills	Type of truck
Boston & Maine.....	120,000	88	1,346	70 ft. 3½ in.	4-wheel
Pennsylvania	120,000	88	1,364	70 ft.	4-wheel
New Jersey Central...	115,800	78	1,480	63 ft.	4-wheel
New Haven	131,000	88	1,488	70 ft. 6 in.	6-wheel
New York Central....	142,000	84	1,690	70 ft.	6-wheel

The trucks used on the Boston & Maine cars are of the 4-wheel Commonwealth cast steel type, equipped with 5½-in. by 10-in. journals and solid steel wheels. They are also fitted with clasp brakes.

The electric lighting is of the axle generator body suspension type, one half of the new equipment having the Safety Car Heating & Lighting Company's "Underframe" system and the other half the Gould system. The lighting equipment includes 16-cell, 300-amper -hour batteries. The lighting distribution to passengers is effected by drop lamps, all located on the center line of the car. The customary upper

Interior of the Boston & Maine Coach

deck sash is omitted, the only openings being those required for the Automatic ventilators. To insure more than the usual natural light, the window sash is brass of the narrow Forsyth type, giving a larger glass area than is possible with the wider style of wood sash. The seats are of the reversible type made to insure the greatest comfort to passengers together with simplicity of design. They were manufactured by Heywood Brothers & Wakefield Company, Wakefield, Mass. The seat covering consists of Chase's figured green frieze in the coaches, and in the smoking cars Chase's Gibraltar leather is used. All other construction details are the same for both coaches and smoking cars. The interior color scheme is cream white for the headlining and lower deck, dull cherry for the walls above the belt rail and dirt gray below. The flooring is of Flexolith cement, with color to match the lower side walls. Three-ply Salamander insulation is used in the walls and roof, with Agasote headlining.

Westinghouse PC brake equipment is used with 16-in.

service cylinders and 14-in. emergency cylinders. The draft gear is Miner friction type A-3-P with Pitt couplers, and the buffers are Miner friction type B-10.

AIR BRAKE MAINTENANCE

BY JOHN P. KELLY

The following communication from F. W. Brazier, superintendent of rolling stock, New York Central, appeared on page 984 of the *Railway Age Gazette* for May 5, 1916:

To the Editor of the *Railway Age Gazette:*

I have read with a great deal of interest J. T. Slattery's letter on the Air Brake Association in your issue of April 14.

First, I want to concur in all that Mr. Slattery has said regarding the better maintenance of air brakes on freight equipment. This is a question that has been up many times, and at the last M. C. B. convention a paper was read calling the attention of all the railroads to the proper maintenance of air brakes and the parts pertaining thereto.

It is useless for one railroad to attempt to do all the adjusting and testing of air brakes. Many of the roads have gone to the expense of fitting up terminals with air testing racks and have the terminals equipped with air so they can have proper pressure to test cars and trains while they are in the yards.

I appreciate the good work which the Air Brake Association has done in calling attention to the importance of properly maintaining brakes, but, unless mechanical and operating officers provide the means and give the time for proper inspection and repairing of air brakes, we will never get any results.

Under the Federal laws we are compelled to have at least 85 per cent of the cars in a train in good condition and the sooner that officers wake up to the fact that this is a question that needs something more than talking about to get results the better it will be for all concerned. Simply accepting cars and getting rid of them without making other repairs than just enough to clear the law will not keep up the air brakes on equipment.

The M. C. B. rules are explicit as to this, and prices for doing the work on air brakes are such that the companies that do it will not be the losers. It is right up to each and every railroad, large and small to do its part, particularly in adjusting the brakes and cleaning and testing the triples properly.

Railroads are made up largely of departments. Operating officers have their special duties, mechanical department officers have theirs, and when we consider the importance of the air brakes and their maintenance and of the good work that has been done by the Air Brake Association we certainly should give that association our hearty support and take some notice of its recommendations regarding this important question.

The men that compose the Air Brake Association are, as a class, of high order, and I thoroughly agree with Mr. Slattery that they need the backing of all railroads in the good work they are doing. It is also up to all railroads to pay more attention to the care of air brakes.

This is a live question; our company has a large force of men attending to the maintenance of air brakes.

F. W. Brazier.

This is a subject that deserves widespread attention. Ever since the Air Brake Association has been in existence it has talked about, and insisted upon, the importance of proper and efficient maintenance of the brakes on both passenger and freight cars; but, as Mr. Brazier well says, "It is a question that needs something more than talking about to get results." This matter has been before the Master Car Builders' Association for many years, and the condition of freight brakes is still so far from being what it should be, that it is, I think, safe to conclude that the membership of the M. C. B. Association must be, by this time, well aware of the fact that something besides talk will be necessary to improve it. What it needed is less talk and more action. We can never talk, or "jolly," the brakes into a better condition, but by putting into practice the recommendation of the Air Brake Association the situation with respect to brake maintenance will be vastly improved.

It may be impossible for one railroad to do all the testing and adjusting of brakes necessary for the whole country, but I do not believe that "it is useless for one railroad to attempt to do all the adjusting and testing of air brakes." Any railroad can do all the work necessary on the brakes to put them in satisfactory operative condition that its present facilities will permit; and it is fair to expect that these facilities should be adequate to the demands of the road's own legitimate requirements. Since the prices paid to the railroads for doing the necessary work on the brakes of foreign cars are fair and liberal there appears to be but little excuse for not doing as much as possible, even to the extent of increasing present facilities, if need be, to take care of neglected foreign brakes. In fact, it seems as though it would be a good way in which to induce all other railroads to get the habit of maintaining their own brakes in good condition if a few energetic, up-to-date railroads would do the work necessary on these brakes to put them in proper shape, and then render the bills.

The cleaning and testing of triple valves is a very important matter, more so nowadays than ever before, owing to the large number of heavy cars hauled in a single train. A single erratic triple in a modern long train can find abundant opportunity to do serious damage. Hence it is of the utmost importance that the men employed to clean, repair and test triple valves should be conscientious, should possess more than the average intelligence, and should be men on whom the railroads can rely for the best quality of honest workmanship, worthy of their implicit confidence.

The "safety first" consideration requires that no imperfectly operating triple be permitted to get into service, and therefore no railroad should permit such valves to go into its trains, no matter how many of them may be offered from connecting lines. Any railroad is amply justified in removing such triples, and applying others known to be in good reliable condition.

There is a recommendation that the Air Brake Association has made, which is included in its recommended practice, that reads as follows: "All air hose should be tested for leakage by the use of soapsuds." Any railroad so disposed can follow this recommendation without waiting for its neighbor to adopt the practice. The air hose should be tested with soapsuds while under standard pressure for the purpose of detecting such as are leaky and porous. Such hose are responsible for a large percentage of brake pipe leakage which is so objectionable in long freight trains, and they are the kind of hose likely to rupture and cause serious damage in such trains, if the rupture occurs while the train is in motion. The loss of air through leakage in a 100 car train will amount to about 66 cubic feet of free air per minute and this leakage in itself amounts to considerable in dollars and cents, in the course of a ten-hour run.

Brake pipe leakage has other objectionable features besides the mere loss of air; it often prevents, in a large measure, the maintenance of uniform pressure throughout the whole brake pipe, causing it to be much lower at the rear end than at the front, thus making the braking power at the rear less than at the front, which is a condition conducive to train buckling in case an emergency application should be initiated at or near the front of the train.

Of course, this recommendation (to use soapsuds on the hose) cannot well be followed in freezing weather; but if practiced when the weather permits, it will enable the inspectors to detect the hose that should be removed before the train departs. After the practice has been followed for some

time it will be found that the porous hose will disappear, and the condition of the brake pipe with respect to leakage will be materially improved.

On cars that have the proper size of brake cylinder there is little need for frequent adjustment of the slack; and therefore no cars now building or being rebuilt should be equipped with a brake cylinder requiring a total leverage of over nine to produce the required braking ratio.

The Air Brake Association will, no doubt, appreciate the nice things which Mr. Brazier says of it concerning the good work it has done; but since it has done so much for the advancement of the air brake, it is only fair to expect that every railroad should give this association substantial support, and see to it that at least one or more of its air brake men, from each department, is in attendance at the annual convention, to take part in the work.

It is very likely that the suggestion made by D. F. Crawford, of the Pennsylvania Lines, at the 1915 M. C. B. convention, that the relations between the Air Brake Association and the M. C. B. Association be made closer, will be productive of much good in the way of better air brake maintenance. Example and demonstration, it is said, is far more convincing than precept, and since there is so much that any individual road can do to improve the brakes without hindrance because of whatever condition may exist upon other roads, it would appear that the only thing necessary to immediately bring about a more satisfactory condition would be simply to put into effect some of those practices which the Air Brake Association, as a body, has been so long recommending, and which wherever tried have proved so efficient.

THE WORK OF THE CAR INSPECTOR

BY W. F. MANDRELL

An expert car inspector's value to a railroad cannot be measured in dollars and cents; there is no estimating the amount of damage and probable loss of life which may result from defective equipment being allowed to pass; or overlooked by incompetent or careless inspectors. The modern car inspector must be a bureau of information. He must know the name and value of any part of a car; he must know how repairs should be made, and also how to bill out repairs made to foreign cars. The Master Car Builders' book of rules and hundreds of special bulletins must be as familiar to him as his A.B.C.'s. He must keep posted on the Master Car Builders' Arbitration Committee's decisions pertaining to the interchanging and running of cars. There are also special rule books issued for the air brake and signal whistle system; car heating and lighting calls for another special set of instructions. Refrigerator cars have a special rule book and even tank cars are coming in for quite a few new regulations. The United States Safety Appliance Act calls for special instructions. All these rules and regulations an inspector must keep in mind as he goes about his work. I have heard some people express the opinion that a car inspector's job was "easy money." They think that all he has to do is to sit down and wait for a train to arrive and depart. At small points this may in a measure be true, but when it comes to terminals and towns and cities where traffic commences to be congested there is a different tale to tell.

For example, I will cite some of my own experiences while holding a position as freight car inspector at the terminal of the road. My duties were to inspect all trains on arrival, taking the initial and number of all cars, whether defective or not, paying special attention to grain cars for leaks in flooring, siding and roofs, and watching loaded tank cars for leaks. At times we had special bulletins requiring us to look out for our equipment that needed re-weighing, and various other things. I had to keep a complete record of defects, whether old or new, and see whether or not defect cards were on cars to cover the damages. For heavy repairs I had to send cars to the shop; for light repairs they were marked for the repair track.

I had to keep posted as to the time trains were due to arrive in order to outline my work for the day. Once a day I had to cover the entire yard on the lookout for defective safety appliances, etc., as in the continual switching and moving of cars there is always something breaking or getting out of order and Uncle Sam's inspector does not send out advance notice as to when he will come for an inspection. I also had to inspect all cars daily in the downtown district where cars were continually being loaded and unloaded. I would inspect each car thoroughly and then mark on the side of the car whether O. K. for grain or other commodities, according to the condition of the car. In cases where cars had bad roofs and were in a general dilapidated condition I would mark them "Route Home Empty for Repairs." In this manner the yardmaster did not have to bother about having the inspector find him a car to load. The switching foreman had his instructions to look on the side of the cars until he found the one he wanted. As there were always plenty of cars unloading this scheme worked out satisfactorily.

I also had to keep close watch on cars placed at the docks to load, especially the refrigerator cars placed for loading bananas, as even in switching them from the shop or "rip" track to the docks cars often became defective. The refrigerator cars are given special attention to keep from having any delay when a train is made up to leave.

On one occasion I found a car with a piece of the flange broken off the wheel; on another occasion I found that the brasses had been stolen from three cars; they were to be loaded that night and had they not been discovered there might have been a serious accident or delay, as these cars had already been oiled and inspected. I also had two interchange tracks to watch. However, this is sufficient to illustrate my point.

When it comes down to interchange work the inspector has to keep many important things in mind. The now popular "Safety First" is the car inspector's slogan, yet it depends upon his good judgment to keep traffic moving and not unnecessarily delay shipments that are ofttimes perishable. He must not only see that car and load are safe to go and safety appliances O. K., but he must look for defects or parts missing, etc., that the company would be held responsible for when the car is delivered to another road. Where there is no defect card already on the car, he must reject it until properly carded.

Railroads are saved thousands of dollars annually by having well posted inspectors on interchange work. The interchange inspector should be "Hail fellow, well met," for I believe a genial personality helps to clear up matters in all walks of life.

The inspector must keep a sharp watch on all open loads, especially piling or steel beams, etc., that are loaded on groups of two or even three cars. He must see that they are properly staked and chained together and that the loads are not too high nor too wide. He must also see that switch chains are accounted for.

In spite of all the extra knowledge a car inspector must have over the ordinary car repairer, in addition to working longer hours and seven days in the week, there still remains very little difference in the wages paid them. This, I believe, is one reason why young men with ambition usually pass by the car department for other branches of the service that offer more inducement in both better wages and quicker advancement. The responsibilities of the car inspector are increasing every year, with a certainty of becoming even more complicated, as modern efficiency and economy are constantly bringing changes for the betterment of the car department, but necessitating more care and watchfulness on the part of the car inspector. I look for the time to come when railroad officers will select men for this important posi-

tion with as much care as they would for the position of engineer.

There would be mutual benefit derived were the railroads to delegate as many of their inspectors as could be spared to the annual meetings held by the Master Car Builders' Association.

STEEL ORE CAR

The illustration shows one of a number of steel ore cars recently built by the Ralston Steel Car Co. for the Duluth, Missabe & Northern.

The side sills of this car are composed of channels having their flanges turned inwardly to provide a flush surface for the application of channel side stakes. The end sills are connected to end sill side sills, which have the corner posts connected to them. The upper ends of the corner posts are connected to top end angles, to which the upper ends of the front and rear inclined hopper sheets are secured. The draft sills extend forward beyond the end sills and to the rearward to the inclined sheets, to which they are secured.

The bolsters are composed of diaphragms connected to the side and center sills and bottom cover plate. The upper edges of the diaphragms are riveted to a floor plate which covers the entire portion of the frame from the hopper sheet to striking plate. This floor cover plate is riveted to the end sill angles, draft sills, and side sills, and has a flange at its rear end which is connected to the hopper slope sheet, forming a girder which permits of the buffing stresses being equally distributed over all parts of the underframe.

Secured to and extending from one bolster to the other are longitudinal or sub-sills spaced a short distance from the side sills. These serve to increase the strength and rigidity of the underframe, and also provide a connection for the door bracket hinges and sloping side floor sheets. This sub-sill is connected to the side sill proper.

The door mechanism consists of links suspended from brackets secured to the draft sills at the respective ends of the lower portion of the car body. The links at one end of the hopper bottom are connected with those at the other end by shafts disposed under the doors, and on these shafts rollers are mounted running into a trackway on the doors. Near the end of the hopper body, short shafts are mounted in bearings, having applied thereto armed crossheads with curved links attached to the arms and the door shafts.

A worm segment is mounted on each short shaft and the hub of the segment is made with a clutch member having a lug on it. Another clutch member is secured to each shaft and made to co-operate with the lugs on the other clutch members. The lugs in the two clutch members are so proportioned as to permit of relative movements of the segment and shaft. Worms are mounted between the draft sills near the ends of the hopper body and are disposed over and enmesh with worm segments. A transverse shaft passes through the worms for rotating them, and this shaft is mounted near its ends in bearings secured to the side sills. The ends of the shaft project beyond the side sills for the application of a device for manually operating it.

Sprocket wheels are secured to the cross shafts and these sprockets are connected by a chain so that when one or the other of the shafts is rotated, motion will be imparted to both worms for turning the worm gears. When the doors are closed they are kept so by the worm gearing, without the necessity for the use of pawl or ratchet devices. When the sub-shaft has been rotated sufficiently to overcome the dead centers of the link mechanism, the weight of the load in the hopper body forces the doors fully open.

Ore Car for the Duluth, Missabe & Northern

A test was made recently with one of these cars loaded with 52 tons of ore, to ascertain the length of time required to dump the load, one man doing the work. From the time the operator applied the wrench to the operating shaft, including dumping the load and closing the doors, the car was made ready for the return trip to the mines in 35 seconds.

These cars are built under patents owned by the Ralston Steel Car Company and were designed by R. R. Weaver, mechanical engineer of that company.

EMPTY AND LOAD BRAKE EQUIPMENT*

Description of Operation in Freight Service; Small Air Consumption One of Its Advantages

BY WALTER V. TURNER
Assistant Manager, Westinghouse Air Brake Company

An "Empty Car Brake," "Single Cylinder Brake," or, to use perhaps the best name of all, "Single Capacity Brake," is the one most generally found in railroad service today. It is one in which a constant braking force is used for all conditions of car loading and one for which the braking ratio is invariably based on the empty weight of the car. With this brake the range in braking ratio will vary as much as from 60 per cent to 15 per cent as the car varies from its empty to its fully loaded weight. It is inevitable that cars braked only one-quarter as effectively as others should close up or pull away, as the case may be, according to the relative positions in the train. That is to say, it is inevitable that slack action—violent slack action—should occur. Some railroads have, in my judgment, foolishly jumped from the

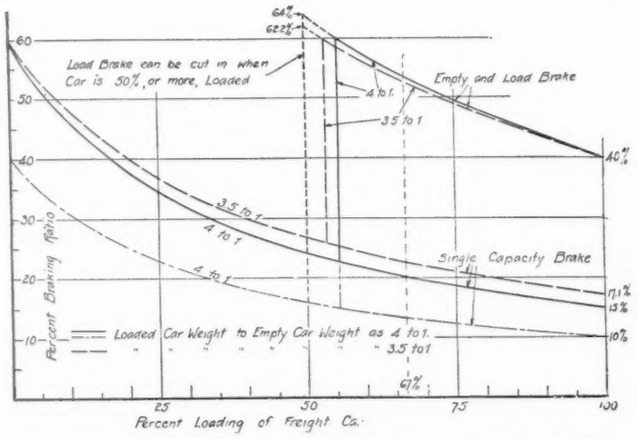


Fig. 1—Chart Showing Braking Ratios for Various Conditions of Freight Car Loading, with and without Empty and Load Brake

frying pan into the fire by increasing the braking ratio on the empty car. This, of course, increases the braking ratio above 15 per cent when the car is loaded, but it is disastrous to braking operations with long trains.

The empty and load brake is one wherein a braking force is used varying with the weight of the car and thereby giving either a constant braking ratio for all conditions of car loading or a ratio much more limited in its variation than in the case of the single capacity car brake. The empty and load brake as designed for freight service has two distinct braking forces due to the operation of one or of two brake cylinders during brake applications. The full service braking force obtained with the one cylinder is 60 per cent of the empty weight of the car, as with the empty car brake. It is used with the empty and partially loaded car. But when the car is loaded beyond a certain point the second brake cylinder is cut into action to assist the first. The total braking force now equals 40 per cent of the weight of the fully loaded car instead of from 15 to 17 per cent with the single capacity brake. The reason 60 per cent braking ratio is not used for the loaded car is that if it were the second cylinder could not be cut in until the car was fully loaded without exceeding the 60 per cent braking ratio. With a 40 per cent braking ratio for the fully loaded car, the load brake can be cut in when the car is a little more than half loaded without exceeding a braking ratio of 60 per cent for that particular condition of loading.

Fig. 1 shows the way the braking ratio ranges for different conditions of car loading, with and without the empty and load brake. Two ratios between the loaded and empty weights are given, namely, 3.5 to 1 and 4 to 1. The increase in this ratio only means a greater contrast between empty and loaded car braking ratios, and this in turn less uniformity of retardation, with resultant slack action, and less safety of control on mountain grades. If, however, the empty and load brake is installed, it may be cut into load operation with 55.5 per cent loading without exceeding a 60 per cent braking ratio where the weight ratio is 4 to 1, or less, and the corresponding point for a 3.5 to 1 ratio is 53.4 per cent loading.

A line representing a 4 to 1 weight ratio is shown starting from a 40 per cent braking ratio for the empty car and drops to 10 per cent for the loaded car. Where the car is either empty or fully loaded at all times, i. e., having no operation with a partial load, and employs the empty and load brake, this 40 per cent empty braking ratio is most desirable. This lower braking ratio is also desirable for the reason that it minimizes the effect of serial action in the pneumatic application of brakes on a long train. While the 40 per cent braking ratio is desirable for the empty and load brake, a 60 per cent ratio has been applied for the reason that cars equipped with the empty and load brake may be passed to roads which do not have empty and load brakes, and which therefore are not expected to cut the brake into load position.

The empty and load brake also has a tendency to reduce the number of slid flat wheels, inasmuch as more uniform retardation is obtained throughout the train. Slid flat wheels are more frequently the result of the cars being "knocked off their feet," so to speak, by sudden shocks, permitting the brake shoes to lock the wheels and hold them, the static friction between the shoes and the wheels being greater than the kinetic friction between the wheels and the rails. However, even though the car is knocked off its feet and thus the wheels

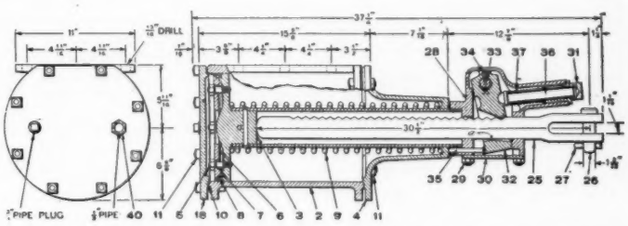


Fig. 2—Load Cylinder, Showing Notched Push Rod and Clutch

slide momentarily, it doesn't always follow that they will continue to slide. For if the pull of the rail on the wheel sliding exceeds the pull of the shoe, the wheel will commence to rotate again and so continue. To slide the wheel from a standstill, or to keep a car off its feet, once it has been knocked therefrom, either the cylinder pressure must be high or the rail bad, or both. Slid flat wheels appear on empty cars much more frequently than on loaded cars.

The shocks being greater with the single capacity brake than with the empty and load brake, it is obvious how prolific shocks may be in slid flat wheels, due to lack of uniformity

*Abstract of a paper presented before the St. Louis Railroad Club, February 11, 1916.

in braking. And thus the role of the empty and load brake in eliminating slid flat wheels and all the other evils arising from slack action is apparent.

GRADE SERVICE

In grade service the advantages of the empty and load brake are at first glance more apparent. In descending a grade a certain portion of the car weight is acting to accelerate it, and if this acceleration is not to take place, an equal opposing force must be brought into play to counteract the accelerating force. In calculating train control on grades it is necessary to consider the internal resistance of cars, but this is neglected in figuring stops for the reason that many tests have demonstrated that in bringing a car to a stop the internal resistance is just about equal to the force required to overcome the rotative energy of the wheels.

The retarding force set up by the brakes on a car is, in terms of the car weight, equal to the braking ratio multiplied by the brake rigging efficiency and by the coefficient of brake shoe friction. Thus, if a loaded car equipped with a single capacity brake has a braking ratio of 15 per cent, a rigging efficiency of 85 per cent and a brake shoe friction of 15 per cent, the retarding force will be $.15 \times .85 \times .15 = .01915$ or 1.9 per cent of the car weight. That is, this retarding force will just equal a net accelerating force of 1.9 per cent, or one due to a grade of $1.9 + 0.4 = 2.3$ per cent, making the above allowance for internal resistance. But this would provide no reserve, no margin for safety or flexibility, because it would necessitate a constant cylinder pressure of 50 lb. (the basis for the braking ratio mentioned) all the way down the grade. Leakage, recharging and the ability to come to a stop when desired would be quite uncared for. Considering time for recharging, length of train, reserve power for making a stop, leakage, etc., the cylinder pressure will average only 30 lb. for the entire descent of the grade. This means that the retarding force will be only 30/50 of 1.915 or 1.15 per cent, and the maximum grade corresponding, $1.15 + 0.4$ or 1.45 per cent. Making the same allowance for the empty and load brake, we find the maximum grade to be

$G = .40 \times .85 \times .15 \times 30/50 + 0.4 = 3.46$ per cent.

These limiting grades stand in approximately the same relation as do the braking ratios for the two types of brake. In each case approximately the same factor of safety holds good. That is to say, the empty and load brake is as safe on the 3.46 per cent grade as the single capacity brake is on the 1.45 per cent grade, the only difference being, as will later be shown, an increase in air consumption of 17 per cent for the empty and load brake.

The empty and load brake will control a train of loaded cars on a certain grade with only one-half the air consumption required by the single capacity brake with the same train on the same grade. This, in itself, shows how much more flexible, safe and economical the empty and load brake is. This reserve may be utilized by handling a train with the empty and load brake twice as long, other things being equal, as the empty car brake train and with the same factor of safety. In the matter of coming to a stop on a grade, the stop distance will be, other things being the same, inversely proportional to the braking ratio.

A train equipped with the single capacity brake, averaging 75 per cent of the full service braking power (average cylinder pressure 37.5 lb., an assumption really too high), that will run away on the 2.3 per cent grade will be held at a constant speed of 20 m. p. h. with the empty and load brake and with 45 per cent of the full service braking power (average cylinder pressure of 22.5 lb.—a very conservative assumption), and its reserve braking force enables it to stop from this speed in less than 500 ft.

AIR CONSUMPTION

The air consumption in braking a railroad train depends upon the number of cars, the brake pipe and auxiliary volumes for each, and the amount and number of brake pipe reductions used. The freight empty and load brake is so designed that when operating in load position, air is admitted to the "empty" cylinder alone until a brake pipe reduction of about 8 lb. has been completed. The load cylinder is then automatically cut into operation. But the empty cylinder has meanwhile taken up all the slack in the brake rigging, the load brake piston not moving at all, due to the use of a special notched push rod and clutch device, until air is admitted to the load cylinder. This cuts down the load brake piston travel to a minimum, making it about 1½-in. instead of the usual 8-in. piston travel. Fig. 2 shows a sectional cut of this device and Fig. 3 the operating mechanism and the relative arrangement of all parts.

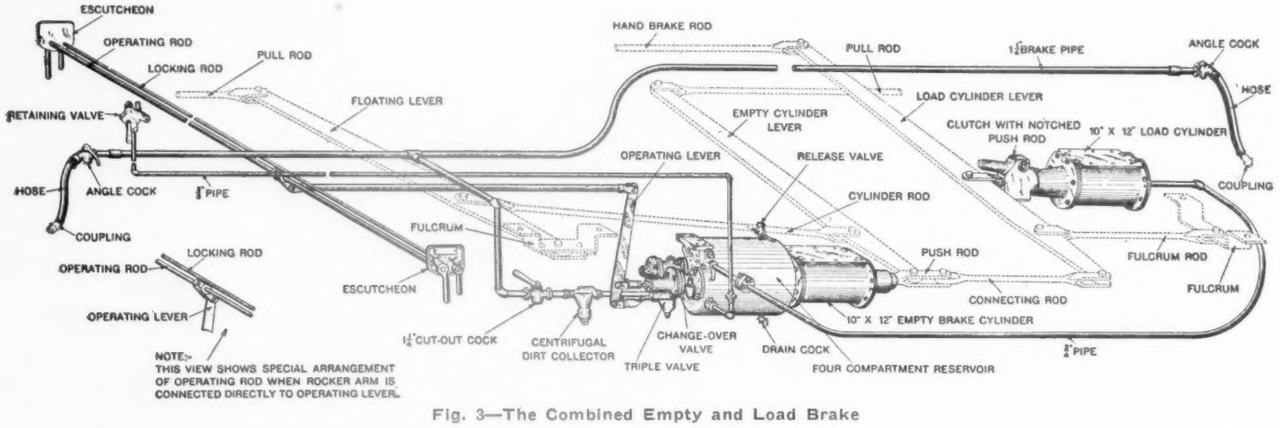


Fig. 3—The Combined Empty and Load Brake

Thus, where the two cylinders, the empty and load, are of the same size, the volume of air required for a certain brake pipe reduction is roughly

$$\frac{1.5}{8} = 19$$

per cent more for the two cylinders than for the single cylinder brake, instead of 100 per cent more, as would be ordinarily expected with the use of two cylinders as compared with one. As the empty brake cylinder takes up all the shoe clearance and slack in the rigging, a high leverage ratio may be used for the load cylinder without any of the evil effects of high leverage on the single capacity brake or on the empty cylinder. If the empty cylinder has a leverage ratio of 9 to 1 and the load cylinder force is multiplied 1½ times by the time it comes to the empty cylinder push rod (see Fig 3), the final leverage multiplication for the load cylinder is $1\frac{1}{2} \times 9 = 13\frac{1}{2}$. Thus, if the empty cylinder is respon-

sible for 16 per cent braking ratio with the loaded car, to the load cylinder is due 1½ × 16 per cent = 24 per cent braking ratio, and the total for both is 40 per cent. This, with the use of the special clutch and notched push rod for the load cylinder as before mentioned, explains briefly why the remarkably low air consumption is possible for the empty and load brake.

The superior air consumption performance and reserve braking force of the empty and load brake may be utilized in several ways. The speed of trains down grades may be increased, the speed restriction or limitation now passing from the brake to the question of wheel temperatures. The length of trains and the loading of cars may be increased or all these increases made and still leave the reserve in air supply and braking force comfortably great; and remember that this means increased traffic capacity, reduced unit costs and correspondingly increased net revenue.

RESULTS OF TESTS ON THE VIRGINIAN

Dynamometer car tests made on the Virginian Railway between Princeton, W. Va., and Kellysville, over a 1.5 per cent grade 10.5 miles long, brought out clearly the advantages of the empty and load brake over the single capacity brake. On this grade with a train of 90 loaded cars, 30 of which were equipped with the empty and load brake, these cars being placed at the head of the train, the train was stopped from a speed of 21 m. p. h. while the speed of a similar train composed of all single capacity brakes was reduced to 8 m. p. h. from the same speed with the same brake pipe reduction. Also the average brake pipe reduction required to control the trains was only half as much for the first train as for the second train. The first train was satisfactorily handled at an average speed of 19 miles an hour, whereas the average speed for the second train was only 16.5 miles an hour.

Just preceding the final application at the foot of the grade, with the train having all single capacity brakes, the brake pipe pressure was only 78 lb. instead of 91 lb., as it was to start with. With the similar train having 30 empty and load equipments on the head end, the brake pipe pressure preceding each successive application was maintained at 93 lb., no difference being noticed between the recharged pressure previous to the first application and that just before the stop at the foot of the grade.

Emergency stops from 23 m. p. h. on the grade with trains consisting of one locomotive, dynamometer car, six loaded coal cars and caboose (brakes on locomotive and caboose cut out) were made in an average distance of 1,780 ft., when the cars were equipped with single capacity brakes. A similar train having cars equipped with empty and load brakes was stopped from the same speed in approximately 720 ft., 40 per cent of the distance required to stop with the single capacity brake.

TRAP DOORS ON OBSERVATION CARS

A large eastern road recently went into the matter of side gates and trap doors on observation car platforms very carefully and it was decided to provide for the trap door opening first and the gate afterwards. This forces trainmen to open the trap and the gate in going back to flag instead of simply opening the gate and jumping off the platform. Similarly in the case of a trainman trying to reach the platform again after a train has started, it will make it possible for him to make use of the steps instead of trying to climb over the trap door with great risk to himself.

It also safeguards against passengers opening the gates, or leaving them in an unsafe condition when the train is running.

Accidents on account of porters being thrown from a train, caused by the train's starting suddenly, are avoided because the men have to step down slightly to reach the gate and are therefore held from being swept off.

TERMINAL CAR CLEANING YARDS*

BY R. N. MILLER

The average railway passenger terminal yard is designed for a two-fold purpose, and the way in which this two-fold purpose is satisfied determines the degree of success of the entire layout. The main function of the terminal cleaning yard is, as its name implies, to provide adequate facilities for inspection, repair and sanitation of equipment used in passenger train service. The secondary function is that of serving as a temporary storage or waiting yard for passenger trains after they have been inspected and made ready and before being advanced to the main terminal for the assigned runs. Therefore, a terminal cleaning yard must possess a location that will lend itself readily to train movements and at the same time not involve too great an initial investment. At the same time it should have such a location with respect to the main passenger terminal as to require a minimum of expense in moving trains to and from the passenger terminal or in the rearrangement of these trains, as in their turning, or the redistribution of the cars in the train units. On that account a well-laid-out terminal yard will, as far as possible, provide some means for quickly turning trains, either in the way of a loop or wye. This last requirement involves considerable yardage, and where this cannot be obtained the less convenient and more expensive method of train turning by switching out the cars so as to rearrange their order must be resorted to.

The total number and the length of the tracks required will depend on the nature of the train schedules to be met and the general class of trains to be handled. Through line trains, with their quota of sleepers, diners, chair cars, day coaches, baggage and mail cars, demand more attention for inspection and refitting than suburban trains intended to handle commuter service only. It is always desirable that a terminal cleaning yard be so laid out that all trains can be placed without resorting to breaking them up, due to inadequate trackage facilities, a condition which, of course, must always be accompanied by additional switching, with its tendency toward increased expense, congestion and confusion. In this way, where the layout is such that tracks are of unequal length, the longer train units would have to occupy the greater lengths of track while the shorter units would be distributed among the lesser lengths, a condition which would sooner or later greatly limit the capacity of the yard. Again, where the layout is such that all tracks are of approximately equal length and amply provided to accommodate trains of maximum length, each track could be operated to best advantage when short train units are met by placing two or more such units on each track and arranging them in the order of their departure.

Where the terminal yard is to serve only as a cleaning and inspection yard and where some intermediate storage or advance waiting yard is provided, the amount of trackage required will depend upon the nature and extent of work or repairs done at the cleaning yard as well as the size and frequency of trains to be handled. From the foregoing it will be seen that such requirements as charging up of storage batteries, renewal of batteries, repairs to axle light equipment, charging of gas tanks, replenishing of diners, sleepers, etc., will add materially to the time required for the simpler operations of coach cleaning: washing and dusting. On this account the time element becomes a very potent factor in the number of trains handled per track.

A cleaning yard, to successfully meet the requirements of modern train service, must also, therefore, provide ade-

*Entered in the Car Terminal Competition.

quate facilities for emergency and light repairs as well as for sanitation purposes. In this way it is possible to return equipment to service in perhaps shorter time than if it were necessary to send the equipment to the nearest general repair shop.

The yard layout should, first of all, include thorough drainage, both surface and sub-surface, so as to prevent the accumulation of pools from the wash water from the cars resulting in general untidiness of the yard and being detrimental to the health of employees. To facilitate the washing down of cars a liberal supply of water spigots should be provided so as to reduce to a minimum the distances which water must be carried. All spigots should be thoroughly protected against freezing and on that account should be of the self-draining type. Steam heat connections should be distributed so that all train units can be properly preheated and in such locations with respect to the tracks that connections can be readily made or broken. Adequate protection should be provided for both the hose and pipe connections, against injury due to accidental moving of trains while still coupled to steam lines, a good plan being to provide for such steam connections at the track bumping posts and every 250 ft. to 300 ft. therefrom, with connections located between the rails.

Air outlets or connections should be liberally distributed, for in cleaning yard work compressed air is much used in cleaning as well as testing. These outlets should be so distributed as to make it necessary to use more than 75 ft. lengths of hose connection or to require hose to be dragged across the tracks in order to get at the air supply outlet. In other words, air outlets should be located between every second pair of tracks and at intervals of not over 50 ft.

Pintsch gas connections should be located at about the same points as air connections so as to insure ease in charging of cars when placed at any point in the yard. A preferable location for gas lines is above the surface of the ground and generally along the outside of the running rails.

Battery charging connections should be provided at frequent intervals, depending upon the length of the cars to be served and their position in the train units. The more usual practice is to locate these at approximately the same intervals as the air connections, making provision against grounding due to dirt and surface water. These connection receptacles should be of the flexible type so as to prevent damage when connections are pulled out by accidental moving of the trains while the batteries are still being charged. Again, each battery charging outlet should be located on an individual circuit so as to provide means for individual control of the charging of each battery at the charging switchboard located at the charging room of the power plant.

Where vacuum cleaning of coach seats, etc., is to be done, provision must be made for vacuum connector outlets where the system employed is of the central plant type. In that case, since the efficiency of a vacuum system falls rapidly with the increased lengths of hose connections, it is advisable to keep these down to reasonable limits, and outlets should therefore be distributed about as frequently as the compressed air outlets—every 50 ft.—and should be of a type which will hold tight at all times so as to prevent the failure of the vacuum due to leakage. Where the portable type of vacuum cleaner units is used, that is, the electric-driven portable unit, electric connections can be obtained at the same points as are used in the charging of batteries. In that case the portable units will have to be direct current machines, while the unit used in the central plant system could be either direct or alternating current.

Trunk line feeders for steam, air and battery charging outlets should be carried in conduits so constructed as to afford easy inspection at all times. These conduits should be self-ventilating on account of steam leaks and on account of possible stray gas leaks from outside gas lines; well drained to prevent accumulation of water on the conduit floors and with roofs of the removable slab type, the slabs being heavily reinforced concrete to sustain the loads due to the trucking of material about the yards. Steam trunk lines in conduit work should be amply protected against expansion and contraction strains, generally by means of the slip joint on account of limited clearances. All steam trunk lines and laterals should be well lagged.

Laterals for both steam or air should be well protected with reliable stop valves to avoid inconvenience due to delays on account of failure of one of the laterals, such as might come about by the tearing off of a connection through accidental moving of a train which was still coupled to the line. With the thorough lagging of steam lines there is but little radiation, and on that account air lines located in the same conduit need not be provided with expansion joints. All conduit work for the battery charging circuits should avoid sharp bends or turns where difficulty would be met in installing the lines. Junction and distributing boxes should be placed so as to avoid long pulls in wiring up.

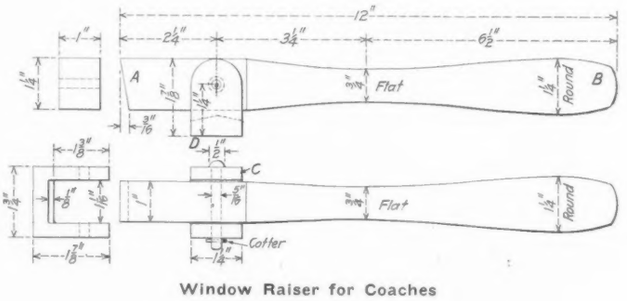
Passageways between tracks where traffic is to be found should be well paved with brick, concrete or creosote blocks so as to provide good means for the transporting of heavier materials and supplies. The latter may be carried out satisfactorily by means of small electric trucks. The small industrial railway is not flexible enough to give good service in a car cleaning yard, and is therefore not considered.

All buildings used in connection with the car cleaning yard should be thoroughly fireproof and sanitary. As a result of the location of buildings being left to the later stages in the development of a yard layout, they are usually placed at one side of the yard proper. This involves more inconvenience in the securing of supplies than would be found where the buildings are centrally located; again, since the yard site determines the nature of the entire layout, the initial cost and final yard facilities often determine the ultimate location of the buildings. In this way it can be seen that each layout, in itself, presents problems which can only be dealt with as individual problems and then only on the basis of final cost.

COACH WINDOW RAISER

BY C. C. LEECH

The material used in the coach window raiser, shown in the illustration, is all hard wood with the exception of the steel pin holding the handle in the clevis *C*. The end *A* of the lever on its upper side may be covered with plush or other soft material and also the under side of the clevis, to prevent scratching the varnish or woodwork of the window sills in the cars. The manner of using the raiser is to place the end *A* under some protruding part or attachment on the lower frame of the window, and resting clevis *A* on the sill to bear down on the handle at the end *B*. It will not fail to start the most difficult window.



Window Raiser for Coaches

Shop Practice

MATERIAL DELIVERY AT THE MACON SHOPS

BY G. W. ALEXANDER
Division Storekeeper, Central of Georgia, Macon, Ga.

At the Macon, Ga., shops of the Central of Georgia, where there are about 1,300 employees, all material is delivered by two delivery boys, who are paid .07c. per hour, and one laborer, who is paid 12½ cents per hour.

Small boxes are placed in the shop buildings at convenient places, and when material is needed the shop foreman needing it writes a storehouse ticket and drops it in the box. At ten minute intervals the messenger boys call at each box, collect the tickets and deliver them to the storehouse. At the storehouse we have a foreman and two laborers who get up all material, placing small items such as cotter keys, nuts, machine bolts, etc., in thick heavy paper bags and indicating on the bag the point in the shop where material is to be delivered, foremen having instructions when writing tickets to indicate on the ticket the engine number, or the name of the machine to which the material is to be delivered.

If when a ticket is presented at the storehouse it is found that we are out of the particular class of material called for, the foreman issuing the ticket is notified and information given him as to the nearest material that can be substituted. If in the foreman's opinion a substitution can be made he changes the ticket accordingly; otherwise the ticket is destroyed by the foreman issuing it. This overcomes the possibility of the storehouse receiving a ticket and not delivering the material, as the foremen require us to either return the ticket or deliver the material called for. This feature is of great assistance to the storekeeper, as the foreman notifies him promptly if any material is out of stock, and it is ordered at once, or if already ordered, it is traced for immediate delivery.

In addition to the messenger service used in delivering material from the storehouse to the shop, we also employ the boys between the machine shop, boiler shop, blacksmith shop, roundhouse and car shop, in carrying certain information from one foreman to another, or in going from one shop to another, getting material which is being worked on at some particular machine, and delivering it wherever it is required. These messengers are encouraged by giving them apprentices' places in the different departments of the shop when an opening occurs, and when a boy is used in messenger service, he familiarizes himself with all machinery and material; consequently when he is made an apprentice in the shop, he is of much more assistance than a boy who has just started in the shops, without the previous experience as a messenger. This also saves quite a bit of material which would be spoiled by an apprentice who had not had the previous training.

We have found from experience that without the messenger service, or an automatic telephone service, considerable time is lost by mechanics sending their helpers to the store for material, and waiting for the material until the helper returns; or that a high-priced mechanic is sent to the store for material, incurring an unnecessary expense in either case because of lost time. With the messenger system the foreman looks ahead as to the material needed by his mechanics and sees that it is provided before it is actually required.

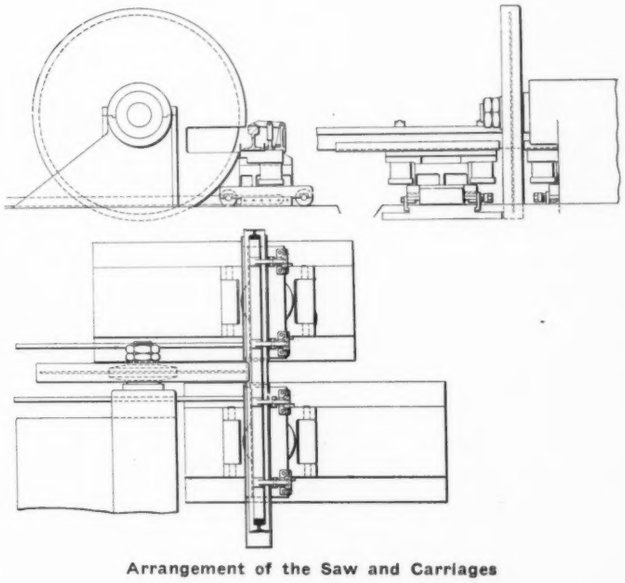
I also believe that the messenger service is superior to the automatic telephone system. In the first place, the installation of the telephone is very expensive, and after installed it requires quite a number of employees in the storehouse to answer all calls. Then in some cases the conversation is misunderstood, and material is delivered erroneously; but where a ticket is written and dropped in the box, and taken up by a messenger, there is very little chance for mistakes in delivery.

This system has been in effect at the Central of Georgia storehouse and shops at Macon for the past eight months, and we have found it very satisfactory and economical.

A RECLAIMED RAIL SAW

BY E. T. SPIDY
Shop Engineer, Canadian Pacific, Winnipeg, Man.

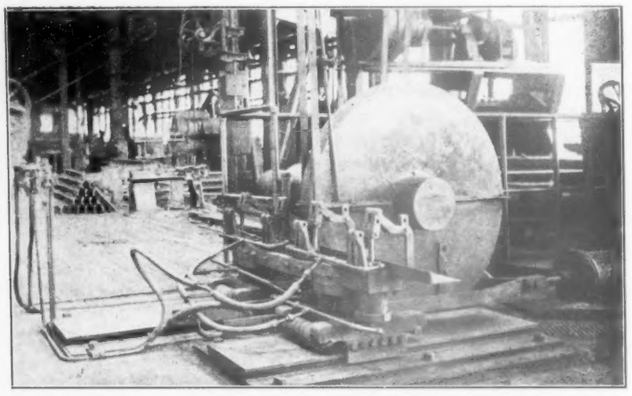
The frog department at the Winnipeg shops was in need of a friction cut-off saw with which second-hand rails could be cut quickly and so that delays in getting quantities of rails cut at various angles would not occur. The machine described herewith was made probably for less hundreds of dollars than the number of thousands of dollars which would have been required to buy a new machine, and it is considered equal in every way to any other type of friction saw.



Arrangement of the Saw and Carriages

The main bearing for the saw shaft was provided by using a heavy tailstock from a scrapped driving wheel lathe. This casting was set on a foundation below the floor level, so that the center of the bearing was 22 in. above the floor level. Split bushings were placed in the bearings and babbitted to suit the 6-in shaft which was turned out of an old axle. On one end the shaft carries the saw, which is made from ¼-in.

boiler plate, and a 16-in. belt pulley is placed on the other end. The shaft runs at a speed of 2,800 r. p. m. Two base plates are bolted to the foundation to form the runway for the rail carriage, which is pulled into and out of the saw by means of a 10-in. air brake cylinder bolted on the floor at the rear of machine. These base plates are from the tool carriages of the scrapped wheel lathe. The two carriages which have been built to run on the base plates each have two 4-in. air cylinders bolted on the under side, the pistons of which are connected to levers which clamp the rail on the carriages. The angle at which the rail is cut is adjusted by changing the relative position of the two carriages. This is



A Rail Saw Built from an Old Wheel Lathe

done by adjusting the length of the connecting bar from the brake cylinder to one of the carriages. The rail-clamp top plates are then turned and locked at the desired angle. When in operation the saw is cooled by a stream of water, the pipe entering the hood over the saw as shown in the photograph.

The actual cutting time with this machine is less than 30 seconds for one 85-lb. rail. The operator stands about five feet away from saw by the two four-way cocks at the left of the photograph. One cock controls the rail clamps and the other the feed in and out of the saw. A 75-hp. motor provides all the power needed.

FITTING DRIVING BOX BRASSES

BY V. T. KROPIDLOWSKI

The finishing of driving box brasses and fitting them to the boxes on a slotter is the quickest method known to the writer, and when the operator is provided with suitable tools and gages the work is perfectly accurate. By the use of the gages shown herewith the work may quickly be laid out, and when the machine operations are complete the brass is ready to be applied without further fitting.

The inside calipers shown in Fig. 1 are very flexible and are capable of three independent adjustments. The two contact points *C* are 4 in. long. These contact points are secured to the arms *M* with 3/32-in. pins inserted through the lugs *O* and the flattened ends of the arms *M*. The other ends of these arms are also flattened and secured in the jaws of *N* with 3/32-in. pins. The stem *L* is ½ in. in diameter and to its end is soldered a contact bar, *F*. This bar also has a 4-in. bearing against the top of the brass fit in the box, the same as the contacts *C*. A 1/16-in. key-way is cut the entire length of the bar *L* and a feather with gib heads is fitted in the hub portion of *N* to keep *F* in the proper position at all times. The calipers are adjusted by means of the thumb wheels *B* and the hand wheel *D*.

When the calipers are inserted in the box and adjusted to size, the gage *E*, Fig. 1, is set to the calipers at the three points *C*, *C* and *F*, the sliding clips *P* being adjusted to the bevel of the toe of the brass and clamped by the thumb screws *A*.

A chuck for holding the brasses is shown in Fig. 2. It is clamped to the slotter table, the projection *K* fitting into the

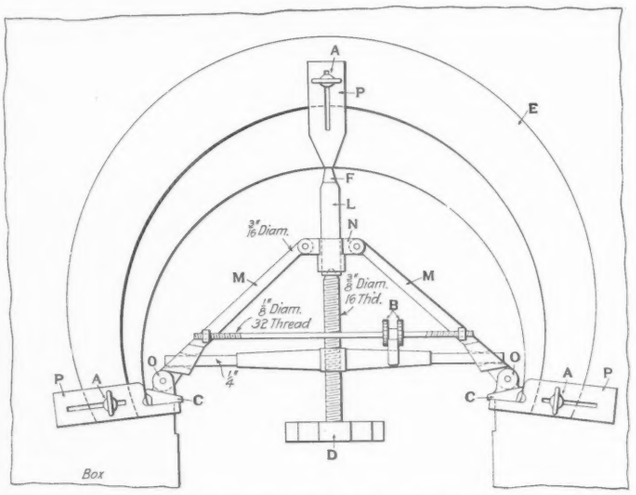


Fig. 1—Caliper and Gage for Laying Out Shoulder Fit on Driving Box Brasses

table center. In a piece of 1-in. pipe *G* is fitted a coil spring which presses against the bottom of the plunger *H*, and keeps the top head *I* up in position at all times.

Fig. 3 shows the tool post used in the slotter. It is made

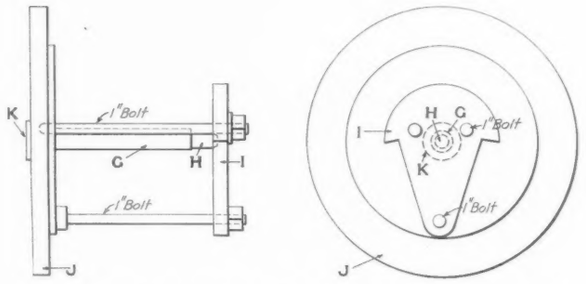


Fig. 2—Chuck for Clamping the Brass on the Slotter Table

in two parts, the upper piece *R* having a slot in its lower end, into which fits a tongue on the lower piece *Q*. The latter is pivoted about the pin *S*, the shoulders of the slot being slightly relieved at *T* to allow the tool to swing back on the

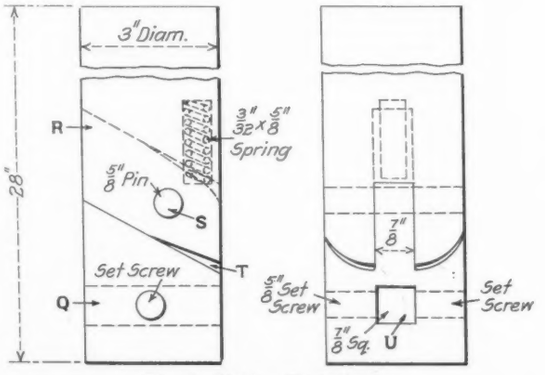


Fig. 3—Slotter Tool Holder

return stroke of the slotter. The tool is inserted into the square hole *U* and tightened with set screws.

As the boxes come from the lye vat, they are examined by

the machine foreman who marks the brasses to be removed. When they have been pressed out the slotter man takes a sheet-steel template (see Fig. 4), of which he has an assortment made from the drawings of the driving boxes for the various classes of engines, and tries it in the box to see how much it is spread. He then lays the template on the rough brass and scribes around it, allowing, by eye, for the amount the box was found to be spread; this operation merely serves to facilitate the centering and setting up of the work in the slotter. He now calipers the box and finishes the brass with one cut. While he is taking the cut he inserts the inside calipers into the box and adjusts them just so they can be slid up and down. The brass fit in the box always tapers slightly,

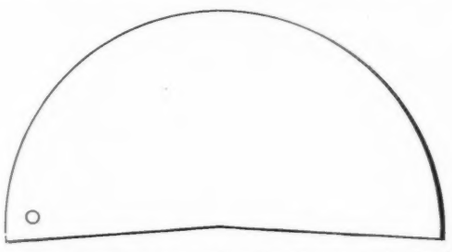


Fig. 4—Template Used in Centering the Brass on the Slotter Table

due to the slotter tool crowding away from the work. By sliding the calipers up and down in the box, he ascertains which end is the largest and then adjusts the calipers snugly at that end. Having this done, he lays the gage *E* on the box and adjusts the clips to the inside calipers. When the clips *P* are adjusted they give the angle of the retaining shoulders, which may be transferred directly to the finished brass and scribed thereon. The ends of the brass are then finished to the lines, which completes it ready for pressing in.

There needs never to be done anything more to the brass, as the ends fit perfectly against the retaining shoulders in the box. The whole operation is being completed in a half hour, including pressing in the brass and all other work pertaining to it.

WASTE AND ABUSE OF BRASS AND BRONZE

BY RUSSELL R. CLARKE

Brass and bronze are probably the most expensive classes of material used in large quantities in railroad service. During the year 1915 one large railroad system consumed 8,750,000 lb. of brass and bronze castings at an approximate cost of $1,050,000, and when it is pointed out that this cost represents only the rough castings, taking no account of the cost of finishing and applying, the large expense involved will be readily understood. Few persons aside from the actual buyers and producers of this class of material have an adequate understanding of its high cost and it is of interest to note that finished castings may cost anywhere from 5 cents to 25 cents per cubic inch. The magnitude of the loss which may result from the abuse of these materials should therefore be evident.

While the value of scrap material is approximately 80 per cent of the price of the new material, the fact should not be overlooked that there is a limit to the use of scrap material in producing new castings. The proportion of new material should never fall below 30 per cent and for the best results should not be below 50 per cent of the total.

Copper base alloys may usually be divided into four classes, depending upon the purpose for which they are to be used. These are ornamental, steam or pressure metal, bearing metal and bell metal. Yellow brass is used principally for ornamental purposes and is made up of approximately two parts of copper to one part of zinc. Small proportions of tin and lead—from one-half to one part of each—are frequently added. A still smaller proportion of aluminum is also sometimes added. German silver and statuary bronze, which are sometimes used for ornamental purposes, have approximately the following constituency: 50 parts copper, 25 parts nickel and 25 parts zinc, and 84 parts copper, 4 parts lead, 2 parts tin and 10 parts zinc, respectively.

Steam or pressure metal, usually known as red brass, is an alloy in which copper, lead, tin and zinc are all used, opinions differing widely as to the proportions to be maintained. Table I shows a number of these alloys, all of

TABLE I—PRESSURE METAL ALLOYS

Copper	Tin	Lead	Zinc
85	5	5	5
86	3.5	3.5	7
86	3	8	3
86	3	5	6
84	4	6	6
88	10	...	2

which contain 85 per cent or more of copper. The last alloy shown, although expensive, is one of the best known, being noted principally for its strength.

The bearing alloys are generally made up of copper, tin and lead, in which small percentages of phosphorus and nickel or ferro-manganese are used. The phosphorus acts as a purifying agent while the use of nickel or ferro-manganese aids in securing a more homogeneous distribution of the lead content. Zinc is unsuitable for use in bearing metals because of its tendency to cause adhesion and heating. The proportions of a few of these alloys are given in Table II. The two mixtures last shown are known as

TABLE II—TYPICAL BEARING METAL ALLOYS

Copper	Tin	Lead	Phosphorus	Nickel	Ferro-Man.
79	10	10	1	...	...
77.5	8	14.5	...	...	...
78	10	12	...	...	...
65	4	30	...	1	...
70	6	23.5	...	...	.5

high lead alloys, the successful control of that element in such large proportions being a difficult matter in the foundry. When bearings of such material run hot in service, pure lead will often ooze out of the casting, showing that it was imperfectly alloyed with the other elements.

Ordinary bell metal is usually about 80 parts copper and 20 parts tin, to this from .5 to 1 per cent of antimony is sometimes added to increase the hardness and improve the tone. Another mixture which is often used is five parts copper and one part tin.

The functions of the various elements may be briefly summarized as follows: copper furnishes body; tin hardens and strengthens the alloy; lead closes the grain, adds plasticity and facilitates machining while zinc purifies and toughens the alloy. In yellow brass the zinc is responsible for the color.

In railroad service brass castings usually seem to be expected to withstand the same kind of treatment that is accorded to iron and steel. The functions of this metal are of an entirely different and more delicate nature than those of iron and steel and it may easily be damaged by treatment which would be entirely suitable for the stronger metals. Brass or bronze which has been injured by rough or improper handling may not give any evidence of its weakened condition. The surface of a bar of iron or soft steel which has been subjected to sharp bending will always indicate the stress to which the material has been subjected, whereas a bar of brass will often show no visible effect of such treatment. To batter an iron nut with a hammer will merely disfigure it, whereas the weakening effect on a brass nut can never be correctly judged.

One of the characteristic physical properties of brass is

its extreme brittleness when heated. Heating followed by immersion in water, however, softens and increases its malleability, while pounding hardens the material and produces brittleness, thus reducing its power of resistance to shock and strain.

If 100 lb. of ordinary brass were to be carefully melted, then cooled and re-weighed it would be unlikely that more than 98 lb. of material would remain. The loss is occasioned by oxidization and volatilization. The total loss in handling, including the melting, ranges from 3 per cent to 7 per cent, varying with the nature of the alloy, the class of work and the shop practice. The cause for the melting loss will be found in the difference in fusing temperatures of the various constituents of the alloy. The melting point of copper is 1,083 deg. C. while that of tin is 232 deg. C. Lead melts at 327 deg. C. and zinc at 420 deg. C. This means that the three low degree elements must be subjected to the melting temperature of the copper.

Casual inspection of the accumulation of scrap on most any railway system will indicate the extent to which brass castings are abused. The writer has personally examined much such material and found the evidence all too plain: a battered and fractured nut, a split or flattened thread, a bent handle, a bruised seat, a shapeless orifice, etc. Probably 50 per cent of the men opening and closing valves either do not know or do not care how to properly manipulate them. It is not unusual to find a brass valve screwed down so tight that it is impossible to open it by hand. When a valve takes its seat and the slack in the threads is taken up it cannot be closed any tighter by jamming it with brute strength. By using a hammer, lever or wrench, the threads will be strained, the seat bruised or the stem bent or twisted. Another source of unnecessary valve wear is the common practice of riding the hand-wheel when operating it. By so doing the gland and stuffing box nuts are worn and the stem thrown out of line.

A wrench should always be supplied and invariably used with spanner nuts. Instead, however, a hammer and chisel are often used to tighten them, their life thereby being very much reduced. Careless handling of car journal bearings is also a source of considerable loss. These are brass castings faced with a white metal lining, the bond of attachment between the two metals being far from infallible. At best it is no more than is necessary to insure adhesion under careful handling and the shocks and jars attending careless handling too often lead to future trouble in service. This condition is appreciated in the foundry, but apparently little attention is given to it elsewhere. Another needless injury which these brasses suffer from careless handling is the nicking and gashing of the bearing surface of the metal lining. In these cavities dust is deposited which, when mixed with oil, often results in a cut journal, a hot box and a ruined bearing.

Under normal conditions the copper-tin-lead alloys are reasonably strong. At high temperatures, however, they become fragile and fracture very easily. The higher the temperature of the metal the more adhesive it becomes and the less effective is the lubricant.

Aside from the physical abuse of brass or bronze parts there are many other ways in which this class of material is wasted. The unnecessary use of steel or iron screws, rivets or pins instead of brass or copper in a brass casting reduces the value of the scrap material. The casting cannot be remelted until the steel has been removed and this is often a task so tedious and expensive as to practically destroy the value of the material. The rejection of castings for minor defects not affecting their serviceability is also a source of waste. There is no doubt but that inspectors are justified in rejecting many castings which the foundry considers serviceable. On the other hand it is equally certain that many others which are rejected could be used. A crown brass for instance, with a small cavity in the top the extent of which is entirely visible from the surface, may be perfectly satisfactory from a service standpoint. And yet, inspectors often reject such castings simply because the cavity barely clears the finishing limit. Remelting always causes a loss and whether he thinks so or not, the consumer is the ultimate sufferer.

Another source of waste lies in the excessive stock which is left on rough castings. Ordering bushings, rod brasses, crown brasses, etc., from patterns with sufficient stock to cover two or three different finished sizes is a much more expensive practice in the foundry than making separate patterns for each size. Moreover the cost of finishing will be less with the latter practice. Considerable saving may also be effected by the judicious use of cores wherever possible instead of casting the metal solid.

Aside from ornamental brass and bell metal, the service requirements for alloy metals are practically identical on all railroads. There must, therefore, be one set of alloys, or a limited range of alloys within which all specifications should be kept, that will answer all requirements. Railroads now purchase these materials under specifications but the scrap is not disposed of in that way. Junk dealers and reduction companies buy worn out brass castings, the analyses of which are entirely unknown. Large quantities of such casttings of varying constituency are melted up, pigged and then sold under specifications according to the analysis of the remelted metal.

It will be noted that copper, tin and lead are common to both steam and bearing metals while zinc is used in the former but not in the latter. In buying the secondary pig most foundries desire to secure it with as low a zinc content as possible, thereby increasing the range of usefulness of the metal. Specifications, therefore, usually call for a zinc content not to exceed one-half of one per cent and reduction companies find it desirable to get rid of the zinc in the scrap material. This is done by raising the temperature of the liquid mass above the volatilizing point of the zinc and holding it there until the zinc is eliminated. At a price of about 19 cents per pound, some idea of the loss involved may be obtained, not to mention the loss of the other constituents.

It will readily be seen that if all worn out castings of steam pressure metal were classified separately from those of bearing metal and that the constituency of each class was within certain standard limits of variation, this loss could be eliminated.

Clay for Babbitting.—Anyone having much babbitting to do knows what trouble it is to keep the clay of the right consistency for "mudding up" when pouring. The use of ground asbestos mixed with engine oil is reported by J. M. Ericson to give fine results. It never gets hard and is always ready for use.—*American Machinist.*

Low-Grade Fuels in Producers.—It is pointed out in a paper recently published by the Bureau of Mines that within the past five or six years marked progress has been made in Europe in the utilization of various kinds of refuse material not ordinarily given much consideration. The manufacturers of gas producers report the successful use of a large variety of fuels, including wood shavings, wood blocks, sawdust, excelsior, coffee husks, rice husks, cocoanut shells, straw and spent tan bark. The figures on fuel consumption reported by the manufacturers are about as follows: With reasonably dry wood (say mixed oak, ash and elm) the consumption has been as low as 2 lb. per b.hp.-hr.; with sawdust the consumption averages 3½ lb. per b.hp.-hr.; and with spent tan bark containing 50 per cent moisture it is about 4½ lb.—*American Machinist.*

SANTA FE APPRENTICE CONFERENCE

This Company Has Almost a Thousand Apprentices. 83% of the Graduates Remain in the Service

One of the distinctive features of the Santa Fe apprentice system is the annual conference of the instructors; this year the meeting was held at Topeka, Kan., May 25, 26 and 27. At these meetings the instructors are addressed by various mechanical department officers, and the important questions arising throughout the year are discussed under the direction of F. W. Thomas, the supervisor of apprentices. This year the conference considered more particularly the system of training freight car carpenter apprentices and boilermaker apprentices. Both of these subjects are so important and the discussions were so valuable that they have been made into two separate articles which will be published in the August issue of the *Railway Mechanical Engineer.* This article deals more particularly with the general problems which were considered at the conference.

The Atchison, Topeka & Santa Fe has the distinction of operating the most successful apprentice system in the United States. On May 31, 1916, this road had 974 apprentices enrolled, these being distributed among the several trades as follows:

Machinists	554
Boilermakers	135
Blacksmiths	20
Car builders and coach carpenters	25
Freight car carpenters	148
Tinners, coppersmiths and pipe fitters	36
Painters	16
Upholsterers	4
Electricians	5
Special course apprentices	31
Total	974

During the past month 20 apprentices were graduated; total graduated for the 12 months ending May 31 is 176. The success of the work in developing apprentices on the Santa Fe is perhaps best shown by the number of graduates remaining in the service of the company. At present 604, or 72 per cent of all the apprentices, graduated since the reorganization of the apprentice department, September 3, 1907, are on the company's payroll. These figures, however, do not truly represent conditions as they are today, for the percentage of apprentices graduated the first two years after the new system went into effect, because of the earlier graduates not having received the full benefits of this system, is much lower than in the succeeding years. The following table gives a better idea of present conditions:

Year	Graduated	Per cent in service
1912	95	74
1913	114	74
1914	127	87
1915	143	94
Total	479	83

In the eighth annual report of the supervisor of apprentices it is shown that 99 of the graduates have been promoted to responsible positions, and of these 34 were promoted during the year 1915.

The plan adopted by Mr. Thomas for conducting the apprentice instructors' conferences is unique. As each different subject is discussed by the meeting, the conference is presided over by an instructor who is particularly interested in the subject. He is not required to present a paper, but simply to act as a moderator, asking pertinent questions of the other instructors regarding the subject under discussion.

The instructors were welcomed to Topeka by M. J. Drury, shop superintendent at that place. He spoke of the effectiveness of the apprentice department, stating that at the Topeka shops it has been unnecessary to go outside of the shops for machinists during the past two years, the new

help required being recruited from the graduate apprentices.

ADDRESS BY F. W. THOMAS

Mr. Thomas, the supervisor of apprentices, in his annual address, stated that a number of the older instructors had been promoted during the year.

Every few days greater demands are made for men for various places, men for better places, men to fill positions caused by promotion or retirement of some of the older officers.

During the past year seven of the graduate machinist and boilermaker apprentices were selected for a special course at the Baldwin Locomotive Works, where they have been made assistant department foremen, being transferred from one department to another at least every two months, and every opportunity being offered to give them all the experience possible in these shops. Four graduate cabinet maker apprentices were sent to the shops of the Pullman Company for similar experience. Recently two other young men were sent to the Pullman Company, these being graduate painter apprentices who were selected in order that they might gain experience in the painting of steel cars, particularly in graining steel so that it will resemble a piece of polished wood. Within a day or two Mr. Thomas said he expected to leave for Pittsburgh, Pa., to take four young men who had shown special fitness for air brake work to the Westinghouse Air Brake Company. Mr. Thomas also impressed on the instructors the importance of more care in the selection of young men who were to be sent out in training for these special duties.

Another of the Santa Fe apprentice boys has, since the last meeting, won the Ryerson-Master Mechanic scholarship at the University of Illinois. Mr. Thomas discussed the recent competition for the next Ryerson scholarship and urged the instructors to keep several boys prepared for competitive examinations, as more scholarships are being offered and he hoped that some day the Santa Fe itself would offer scholarships to a few of the most deserving of its young men. He pointed out also the great value to be obtained at college by a young man who had first served his apprenticeship.

During the past year more of the graduates have been promoted to foremanships than ever before and several of the older instructors have been promoted to better positions. Many roads have had difficulty in securing competent men for federal valuation work; the Santa Fe has had no difficulty whatever in filling these places, and the Government officers have especially complimented the road on the high quality of the men who have been so readily selected for this work.

MR. PURCELL PRESENT

John Purcell, assistant to the vice-president and in charge of the mechanical department, spent all of Friday and part of Saturday at the conference. Mr. Purcell gave the instructors considerable encouragement in their work, promising them all the support necessary to make it a success. He laid special stress on the necessity of giving the apprentices *all the experience* possible to be obtained in their various trades. He commented also on the importance of the apprentices having knowledge of the instructions in the Locomotive Folio, a book containing sketches and other information covering standard practices to be followed in repairing locomotive equipment. He cited several incidents showing the importance of following established standards; among them was an instance concerning flue failures on a certain portion of the system. The locomotives were having chronic trouble with the flue leakage and upon investigation it was found that at one end of the division on which these engines ran, the boilermakers were using beading tools of a certain contour, while at the other end of the division the boilermakers used beading tools of a different contour. Every time the flues were beaded the metal was worked out of the bead to the extent that it was impossible for the flues to remain tight.

Mr. Purcell encouraged the instructors carefully to consider any new ideas submitted by the apprentices, or by any of the other workmen in the shops regarding labor-saving devices or more economical methods of doing the work. In every case, however, care should be taken to give proper credit for these ideas.

In his various talks at the meeting, Mr. Purcell displayed great interest and intense faith in the entire apprenticeship scheme, giving to the instructors the benefit of his years of experience and inspiring them with a knowledge of what could be accomplished and what the management was expecting of each of them in the training of apprentices.

CO-OPERATION OF LOCAL OFFICERS

F. E. Myers, apprentice instructor at Clovis, New Mex., presided, opening the discussion as follows: There is one thing on which we will all agree and that is we will not have a successful apprentice department unless we do have co-operation from the local officers. The main thing to remember when we go to the officers and ask for their co-operation is that these men are in charge of the shop and if our ideas and methods will not help them they are not going to be very enthusiastic about co-operating with us.

The instructors agreed that in order to be successful it is very important to be on the best of terms with all the local officers. Many suggestions as to how to gain the confidence of the foremen and how to keep on good terms were offered. Each foreman must be studied and a method for individual co-operation found. All differences between the apprentice department and the shop foremen should be handled with them direct, and never over their heads without giving them a chance to right matters themselves. No partiality should be shown in dealing with the foremen. An effort should be made to talk with each of them about his work and particularly how the apprentice instructor may help him. A regular meeting of the local apprentice board, at which all apprentice matters are thoroughly discussed, was shown to be an important factor in securing this co-operation.

Where trouble is experienced in getting the boys changed it is usually adjusted by sending a letter to the general foreman with a copy to the master mechanic and the supervisor of apprentices, stating what changes are desired. Few instructors reported any difficulty in securing co-operation of the foremen and all reported the heartiest co-operation of the master mechanic and the mechanical superintendent. They particularly appreciated the interest taken by the higher officers, and reported that the master mechanics were visiting the school rooms more and more and never failed to show the apprentice school to visitors from other roads, thus indicating an interest and pride in what the apprentices were doing.

Following the discussion of this subject Mr. Thomas read a personal letter from J. R. Sexton, mechanical superintendent at La Junta, Colo., in which the latter expressed his appreciation of the good work being done by the apprentice instructors and apprentices. In his territory he had not employed a mechanic for over two years without first trying to secure a graduate apprentice to fill the vacancy. For two years past 100 per cent of his graduates had remained in service. He now has a total of 14 graduate apprentices holding official positions in his territory, many of these important, such as division foreman. He attributed the success of the apprentices and graduates to the careful selection of boys in the beginning; thorough investigation and

elimination during the probationary period, or afterward, if necessary; investigation and adjustment of any charges of mistreatment or mismanagement; giving the graduates full journeyman rate immediately upon graduation; and considering the desires of the young men themselves when making transfers. There is not a point in his territory but has graduates working in some capacity, and at nearly all points the more important jobs of machine, bench, and erecting work are handled by the graduates, with a full quota of graduates in the roundhouses.

LIVING UP TO STANDARDS

C. W. Smith, apprentice instructor at Needles, Cal., presided. It was pointed out that the eight or nine years of experience in training the apprentices had resulted in the adoption of certain standards for handling particular questions, and the instructors were urged to live up to these standards. The supervisor of apprentices explained that he had given the instructors a great deal of liberty in dealing with apprentice matters at their various shops, but there were some features which must be handled uniformly at all points and it was up to the instructor to see that these instructions were lived up to.

DISCIPLINING APPRENTICES

D. R. Cook, apprentice instructor at Shopton, Iowa, acted as chairman. It was believed to be highly necessary to be strict in the administration of discipline. Those who have tried both the lenient and the strict methods in the nature of experiment have found that by insisting that the boys adhere strictly to the rules of the shops, far better results have been obtained. Certainty of discipline rather than severity is most effective. While it is necessary to be strict in applying demerits for offenses, it is just as necessary to be equally fair with every apprentice in removing demerits when subsequent good behavior and attention to duty justify this. With a large organization such as the Santa Fe it is necessary to keep track of every boy individually by the demerit system, as it is impossible for the supervisor of apprentices at his headquarters to properly check the performance of the large number of apprentices without the use of some such system.

SELECTION OF MEN FOR SPECIAL WORK

J. H. Linn, assistant to the supervisor of apprentices, gave a talk at the closing session on the selection of men for special work. He spoke of the rapidity with which the apprentice graduates had been promoted during the past year, and called attention to the importance of carefully selecting the boys for the jobs most suitable for them. The boys, if handled correctly and studied properly, will be found to be especially adapted for one position or another. This should be kept in mind, and when recommendations are asked for appointments, the instructors should be in a position to promptly fill them.

It was pointed out that at no time previously had so many calls been made upon the department for recommendations of young men who could qualify to do certain special work or for executive positions. The policy of the management in filling all vacancies with men in the employ of the company and of giving preference to the graduates has given the apprentice boys a wonderful opportunity for advancement and the instructors an opportunity to prove to the company the value of the work they are doing. The instructors were urged to study each boy carefully and to get so close to him that they may be in a position to know not only the boy's experience, but also his habits and ambitions. When they have learned of a boy's special fitness for any particular class of work they should pass this information on to the supervisor of apprentices and to the master mechanic and mechanical superintendents. The instructors should not wait until a vacancy occurs, but should find out each boy's special fitness, and after giving him as broad training as possible on the work of his trade should give him opportunities for development along the lines for which he is especially fitted. In selecting these young men three things are to be considered. First, the boy himself; second, his fitness for the particular job in question; and third, his experience and training for such work.

SPECIAL APPRENTICES AND SPECIAL COURSE APPRENTICES

In the discussion of this subject the supervisor of apprentices stated that the results formerly secured from the employment of college men as special apprentices had not been very satisfactory, and that formerly these men were given much special work and not sufficient practical work; since these young men are now being kept closely in the shop and required to thoroughly master the work of their trade much better results are being secured. Special apprentices in general were found to be slow in doing the work in the earlier stages of their apprenticeship, this probably being due to the colleges requiring them to do such careful, exact work, regardless of the amount of time required for it. Some of these men had failed to mix well with the other shop men and had been impatient for advancement. Many of them leave the service, some because of greater financial inducements elsewhere, others because of their unwillingness to go through the regular grind, others because of their unfitness for railroad work.

The class of special apprentices in service at the present time is said to be better than at any time previous. They seem brighter, more adaptable to the shop work, and show greater possibility for leadership. This improvement is due partly to greater care in the selection of these young men and partly to the greater amount of practical experience given them. The special course for the last year of their apprenticeship has been giving these men a greater variety of training and fits them better for foremanship. The monthly letters which they have been called upon to write have taught them to be more observant in the shop and have helped materially in developing their executive ability.

This special course is open to certain of the regular apprentices also, and the supervisor of apprentices stated that just now there was a contest on to see which would turn out the better, the college man who served his special apprentice course, including the special course, or the regular journeyman apprentices who are given this course. Each instructor has been called on to report the progress of his special apprentices as well as the special course apprentices, and the reports indicate that these young men are doing particularly well.

OTHER DISCUSSIONS

The conference was also addressed by J. W. Gibbons, master painter of the Santa Fe, who gave a talk on the general subject of paint, explaining in some detail the different services required of paint and the effects of different ingredients in the paint. He explained a series of tests that he has been conducting for the past year or two for the Master Car & Locomotive Painters' Association, showing the effect of the weather on different paints.

D. M. Lewis, representative of the Westinghouse Air Brake Company, gave an interesting talk on the care and maintenance of air brakes, and the best methods of teaching this subject.

The convention was a very enthusiastic one, every instructor entering heartily into the various discussions. Although much has been published regarding the success of the apprenticeship system of the Santa Fe, it is not generally known how thoroughly this company has gone into the question of educating and training the young men who are to be its future mechanics. Mr. Thomas' remarkable success

has been largely due to the class of men he has selected as instructors, all of whom are men of the Santa Fe's own making.

ANALYZING ENGINE FAILURES*

BY A. PARK

There are so many causes for engine failures that the average railroad man will say it is a case of genuine luck to operate for any length of time without a failure; yet there are many divisions on which a failure is a rare occurrence while on neighboring divisions, with similar types of power, there are all kinds of locomotive trouble.

Locating the real cause of a failure after it has occurred is very often a complicated matter and some of the reasons put forth by the roundhouse forces are as interesting as a dime novel. On the other hand, we find many men who are gifted in locating the exact trouble—as they think—and then will apply such absurd remedies that very often the result is a complete change from one extreme to the other.

It is the ambition of every roundhouse foreman and other mechanical department officer to eliminate all failures possible, and while it is impossible to work out a regular standard plan or organization to meet every requirement of the many different terminals throughout the country, there are certain things in common that should be given attention, the most important being the analyzing of the trouble so that the proper remedies can be applied. After a failure has occurred there is no use making any radical changes or corrections unless to eliminate the primary cause of the failure. The very best of good workmanship will not prevent future trouble unless applied at the proper place. All too frequently the average roundhouse man will only look for the "symptoms" of the failure and will not get down to the exact cause. Hot boxes are one of the worst evils to contend with, for when a journal is reported as running hot everything else is checked except the fact that perhaps there was too much packing in the box. One of the old-time ideas in packing boxes was to put in all the packing the box would hold and then add a little more for good measure, and the adding of the "little more" did the trick, for it prevented the oil from getting through the packing properly.

The question of who should be the proper person to analyze the different engine failures is very hard to settle, for we cannot expect the roundhouse foreman to neglect his other numerous duties to follow up some failure that is liable to require a laboratory test before it is solved. But the cure of engine failures has such a wide bearing on the cost and schedule of train operation that it would seem as if the field were big enough to demand the entire services of a mechanic who could devote his time to analyzing failures. It must be admitted that some failures are traceable to poor workmanship in both the roundhouses and general repair shops, but these cases are so self-evident that they do not require much analyzing. The art of "putting it up" to the other fellow should not be tolerated, for some men do cover up their own shortcomings in this manner, and there are many good foremen who have lost their jobs simply because they were apparently at fault. When a failure occurs, do not discharge the foreman till the failure has been thoroughly analyzed. In one case where crank pins were giving a great deal of trouble by running hot it was thought that the work was not given enough personal attention by the foreman, until it was discovered that the pins were too small for the right amount of bearing surface; while in another case, where the engine truck bearings had been causing trouble by running hot, the blame was placed on the box packer till a thorough investigation showed that the axles were too small. This investigation developed the fact that the box packer was a very conscientious workman who had been giving these particular bearings a great deal of attention and study, and in fact had been buying extra lubricating material out of his own pocket so as to overcome the hot bearings, but he could not stop them, and it was found the real trouble was in construction.

On the other hand, there are many failures charged up against the mechanical department for which they are in no way to blame. We do not expect as much from an engine that has made a big mileage as we do from a new engine, and yet the transportation department will make no variation in the tonnage, with the result of a breakdown. Some roads claim that it pays to give an engine a general overhauling twice a year rather than to give one overhauling and maintain the running repairs in the roundhouse. From an economical standpoint, it will cost a trifle more to give the two overhaulings, but the costly engine failures are not as liable to occur and it is also possible to reduce the roundhouse repairs. Then, again, it gives the engine a higher average efficiency rating. In making either an efficiency rating chart or a maintenance cost chart, it is very noticeable how quickly the efficiency decreases after three months of service and how the maintenance cost increases after the same length of service.

Very often, in analyzing failures, economical features are developed, for when there is a failure in material, it is usually a fact that if a higher grade of material had been used the failure would not have occurred. Economy should be practised, but not to the detriment of service. Welded safe end tubes are all right unless too many safe ends are used. There should be some definite number of safe ends that can be applied, and after the limit has been reached the old tube should be scrapped. One road has adopted the very wise plan of using tubes from the longest boilers in short boilers after they have had a certain number of safe ends applied.

Poor design is one of the worst features the roundhouse man has to contend with. When a part requires a great amount of attention, and it is very hard or almost impossible to get at it with the regular tools, it stands to reason the part will not get the attention that should be given it. This idea applies to places where nuts or bolts work loose quite frequently, and it is impossible to get at them with wrenches; it is then necessary to do all tightening up with a set. The practical mechanic is confronted with some difficult propositions, and when he does come in contact with any of these impossible things the matter should be taken up with the "analyzer" at once so that corrections can be made before a failure occurs and is charged to lack of attention. Weakness of equipment should also come under this head, for after an engine has been in service some time and it is noted that some important part is not going to stand up under hard usage, immediate steps should be taken to have it reinforced.

We frequently hear a roundhouse foreman, in excusing some failure that has happened, claim that it was a "man" failure, which places the blame on the engineman. This is a poor excuse, for while it is admitted that there are some failures which are caused by the engineman losing his head, the main reason, which should be developed by thoroughly analyzing the trouble, generally shows some mechanical defect. A cause of a great amount of trouble is water in the cylinders and the breaking of front cylinder heads. Every time this failure occurs the roundhouse foreman will blame the engineman—which is right to some extent—and the engineman will of course lay the blame on poor cylinder cocks. These failures can be prevented to a much greater extent if everything is made as simple and plain as possible so that it will be "fool proof." It is all very well to tell how certain breakdowns should have been handled after they have happened, but at the time when everyone is in a hurry the right move is not always made. The best method to cover these conditions is to determine the cause and then apply a proper remedy so as to prevent a recurrence. One of the most annoying failures the roundhouse has to contend with is the "burning up" of an air pump so that the engine has to give

*Entered in the Engine Terminal Competition.

up the train before starting out. This trouble can be prevented to a great extent by the engineman.

Failures from lubrication will always occur till the engineman and roundhouse force are thoroughly educated as to the correct methods and proper time of applying sufficient lubrication. To investigate a failure of this nature, one would be led to believe from the standpoint of the engineman that he never had sufficient oil, while the roundhouse foreman will claim the supply was "enough to take a bath in." We all know the value of a drop of oil at the right time, and if a good failure "analyzer" can investigate both sides of the question with the view of preventing a possible engine failure, it is almost a foregone conclusion that a just decision will be rendered.

One great trouble with the roundhouse force is that if they enjoy a short period of having no failures they consider their work so good that they have the situation well in hand and will let up a little on their attention to the small items. In the meantime, so many small things are getting the upper hand of them that all at once everything goes all to pieces and the cry goes forth that an "epidemic of failures" is occurring and immediately everyone becomes overworked. There is much discussion of whether or not failures can be prevented "before they occur" by close attention and good work and, while the question has never been definitely settled, it is a fact that there is a decided decrease in the total number of failures if proper steps are taken to prevent them. A good example of this idea was the experience of a road where the mechanical department began to apply new fireboxes to a certain class of engines before the engines had been in service for any great length of time. The officers of this road were advised by their boiler department when to expect the fireboxes to give out and rather than suffer several costly failures it was decided to take the work in hand before anything happened. The result was less trouble in the roundhouse, no failures, and engines that were always in good condition. This same type of engine was used on a neighboring road, but no attention was given to the renewal of the fireboxes, and the result was not only several failures, but just at the time when the road needed the power the most the engines were continually tied up for boiler work.

One of the many strong arguments in favor of a regular man for the specific duty of analyzing engine failures is the unprejudiced manner in which he can investigate the work and the fair decisions he can render, for he is not trying to cover up any of his own shortcomings and will place the blame on the guilty party. A roundhouse foreman who is at fault will tend to show up certain things in a strong light so as to clear himself of any responsibility thereby covering up to some extent the real cause. Other officers who conduct such an investigation must put the blame on someone and they are liable to enlarge small points so that the *apparently* guilty man will have to accept the blame. One of the evils of this nature which might be mentioned is failures from engines not steaming, cause given as "poor coal." While it is admitted that perhaps the coal is not all that is desired, an impartial investigation would develop that the steaming qualities of the engine were not the best, and if the engine had been in proper shape, it might have made the trip without a failure. Still further investigation would sometimes develop the fact that in addition to poor coal and a poor steaming engine, the real cause of the failure was due to a fireman who did not understand his business very well. Comparatively good results can be obtained by a fireman who is familiar with the best methods of firing and in a case of this kind the blame should be distributed between all three of the causes instead of placing it all against "poor coal."

One reason why some failures are not thoroughly analyzed is because they pass through too many hands before any definite action is taken. A large amount of unnecessary correspondence is caused by some high officer starting an investigation and every other officer under him writing letters on the same subject. The roundhouse foreman writes a letter to his superior officer, and the same routine is carried out till at last the original report reaches headquarters and the meaning has been changed so many times that it does not resemble the original report at all. How much better it would be for some one man to handle all the investigations, and if anyone on the road wanted an explanation there would be one man who had not only made a personal investigation, but had also seen the result of the failure and knew every phase of the case.

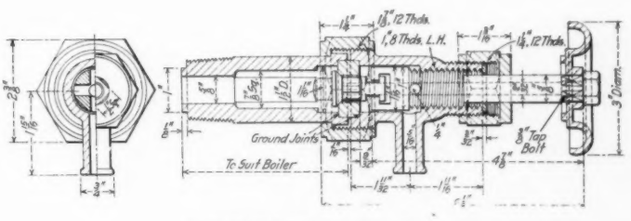
One case of misapplied discipline will do a great deal of harm. It is necessary to apply discipline in some cases so as to keep down to the minimum the failures that will happen if the workmen are allowed to do poor work, but if a workman can get away with a poor job which in turn causes a failure, the foreman in charge should stand some of the blame. By having an official investigator the foreman will have more time to devote personal attention to the quality of work done by his workmen.

If an engineman brings his train to the terminal after the breaking of a part the part that fails should be investigated just as thoroughly as if a long detention had occurred. Some enginemen will make up the time lost in correcting a slight breakdown so as to arrive at the terminal on time, and the breakdown will not be reported as a "failure." Then, again, the light in which failures are held on some roads tends to cover up the small failures that in some cases serve as a warning of possible greater failures. A failure is the warning that something should be given immediate attention. If a small part on some particular engine gives out, it is probable that all the engines of that class will develop the same weakness and the time to prevent trouble is before they give out.

Eternal vigilance is the key to successful operation, but if the eternal vigilance is misdirected by a poor or wrong analysis, which is very often the case, the result is a waste of money and time and the cause of much worry on the part of the operating officers. Surface indications are only "symptoms" and corrections should not be based on hasty conclusions made on surface defects, but there should be a thorough analysis so as to reach the root of the trouble. Modern roundhouses will not solve the failure problem unless they are used as a place to develop the "why" of engine troubles.

THOMAS-LANGLEY GAGE COCK

Several years ago T. J. Langley, assistant superintendent motive power and E. Thomas, master mechanic of the Oregon-Washington Railroad & Navigation Company, designed a self-grinding gage cock which, after several modifications made as the result of service tests, has finally been developed to the form shown in the illustration. The



A Self-Grinding Gage Cock

purpose of the device is to provide a free opening to test the water level, a tight closing to prevent leakage,—easy operation, and a means whereby the valve can be ground free of obstruction without the use of tools and while the boiler is under pressure.

If leaking develops a slight twist of the handle to the

left and right is all that is usually required to quickly grind the valve free, so that it will close tightly. In aggravated cases it is sometimes necessary to twist the handle back and forth several times. While this is being done the pressure in the boiler holds the valve tightly against the seat. When it is desired to open the valve the handle is turned in the usual way, except that the valve merely turns on the seat, and does not open until one full turn has been completed, when the stem commences to force the valve proper off its seat. In ordinary practice, however, the engineer in closing the valve will only turn the handle until the valve seats, so that it may be opened with the same amount of movement as an ordinary gage cock. In case a little scale gets under the seat, by turning the valve to the right and left quickly, it will be displaced or ground off.

The gage cock is made so it can be cleaned out under pressure by using a hollow stem. This construction is especially adapted for use in bad water districts.

Gage cocks of this type are said never to have given any trouble from leaking. The only work required has been to remove and clean them according to law. Should any work be required the cock can be placed at any angle without undue turning of the nipple in the boiler.

THE OPERATION OF A LARGE ENGINE TERMINAL*

BY T. H. ADAMS
Assistant Foreman, Norfolk & Western, West Roanoke, Va.

The principal point in getting results from a large engine terminal is that the man in charge have the complete co-operation of his subordinates and the full confidence of his superiors. He should work in perfect harmony with the road foreman of engines and the division despatchers, and without this I believe his most sincere efforts would be without avail. At West Roanoke this practice is followed out in connection with a well organized working system. I personally follow the working of the system in every detail, and I believe that the greatest success is secured by the man in charge being "on the job" at all times and all the work should be followed up closely.

There are turned at this terminal on an average 140 locomotives per day, of which about 50 are Mallet compound engines. We have a roundhouse of 40 stalls, and our force is divided up into six departments consisting of the passenger engine repair force, freight engine repair force, machine shop, boiler force, hostlers' gang and laborer gang, each unit having its own foreman. The men in each department are well organized and instructed in their line of work and special duties are assigned to every one.

When an engine arrives on the relieving track a tool inspector checks all the tools and makes out a report on a form provided for this purpose, noting any shortage, which is at once investigated and taken up with the man responsible. The hostler takes charge of the engine and examines the boiler wash card to see if the locomotive is due for washing, examines the firebox for leaks, and tests injectors, gage cocks and check valve for defects. The engine is then given a spot test under steam pressure to find any steam defects that may exist, a report of which is made and attached to the engineman's inspection report.

The engine is then taken to the ashpit, where the fire is cleaned or drawn; coal is supplied and the engine moves on to the roundhouse. Great care is used in selecting the coal for the engines on passenger and important freight runs so as to reduce steam failures on such runs to a minimum. This is done by an arrangement of our coal chute, which is provided with three compartments, one for passenger engines, which get the best grade of coal, one with run-of-mine coal for hand-fired freight engines, and one with slack coal for stoker-fired engines.

On the arrival of an engine at the roundhouse it is carefully inspected by a competent inspector, who makes a report which is attached to the engineman's report; the work is then copied off by a clerk and distributed to the various workmen, who, after completing the work under the personal supervision of their immediate foreman, sign for it on the work report, which is in turn checked by the foreman in charge and marked O. K. before the engine leaves the roundhouse.

The engines are then taken out of the house and inspected by an outgoing inspector and given a spot test for steam leaks before being put on the train. The man making this inspection reports to the foreman any serious defects he finds and he examines the report to see if the incoming inspector reported them, investigating each case to see if the workmen are doing their work properly. In this way we keep all the men "on edge," and to this we attribute our good record with the government inspectors, having had only two engines withdrawn from service at this point since the Federal law has been in effect.

We have had a record system in use at this point for about one year, to which we attribute a 40 per cent reduction in engine failures. It is carried out by suspending any workman whose carelessness or improper workmanship results in an engine failure. A notice of all suspensions is posted on a bulletin board, and we have not given a suspension that did not result in making a better and more careful workman out of the man receiving it, and the moral effect among the other workmen is decidedly noticeable.

I personally follow up the condition of the power and inspect each engine thoroughly once or twice a month, rendering a monthly report to the superintendent of motive power as to locomotives' condition. We maintain a general average of about 40,000 miles between general overhaulings of the engines. This is kept up by giving the engines light repairs in the roundhouse. We have found that it pays better to do every job the day it is reported and found necessary than to postpone it to some more convenient time, and by this practice we have gained the confidence and co-operation of the road foreman and engine crews.

After the engines are ordered by the transportation department they are taken in charge by hostlers, who get the fire in good condition, inspect the engine carefully, check all tools, coal the engine, if necessary, fill tank with water, fill lubricators and place the engine on the train. The engine crews report 15 min. before leaving time, which is ample to inspect the engine and oil the machinery. By this arrangement we have greatly reduced delays to engines after they are called.

We follow up the expense problem very closely. Foremen check all orders on the storehouse for material, and the storehouse in turn furnishes each foreman a daily itemized account of all material used by his department, showing the cost and giving a comparison with the day previous and the same day in the month previous; in this way we keep the material expenses before the foreman at all times.

The roundhouse and premises are kept in a neat and clean condition; this is practiced so thoroughly at this point that I believe every person connected with our force takes a special interest in it.

One most important consideration in reducing terminal delays or the turning time of locomotives is to avoid congestion on the ashpits or the tracks between them and the roundhouse, for when engines are kept moving on these tracks the entire force of the engine terminal is busy.

*Entered in the Engine Terminal Competition.

USE OF FIRE BRICK.—To reduce the maintenance cost of furnace lining in stoker-fired, forced-draft boilers, a high-grade fire brick is used up to the fire line. A bauxite brick is commonly employed for this purpose.—*Power.*

A Locomotive Inspection System

Designed to Produce Thorough Inspection and Facilitate Compliance with the Federal Rules

BY N. M. BARKER
Master Mechanic, Copper Range Railroad, Houghton, Mich.

Efficient inspection is recognized as an important factor in the economical operation of motive power. In making proper repairs to the defects disclosed by such inspection, the possibilities of many costly delays, failures and even serious accidents are very greatly lessened, and either a longer period between shoppings or an equivalent reduction in the cost of locomotive mileage is insured.

To secure such inspection it is obvious that the requirements involved are:

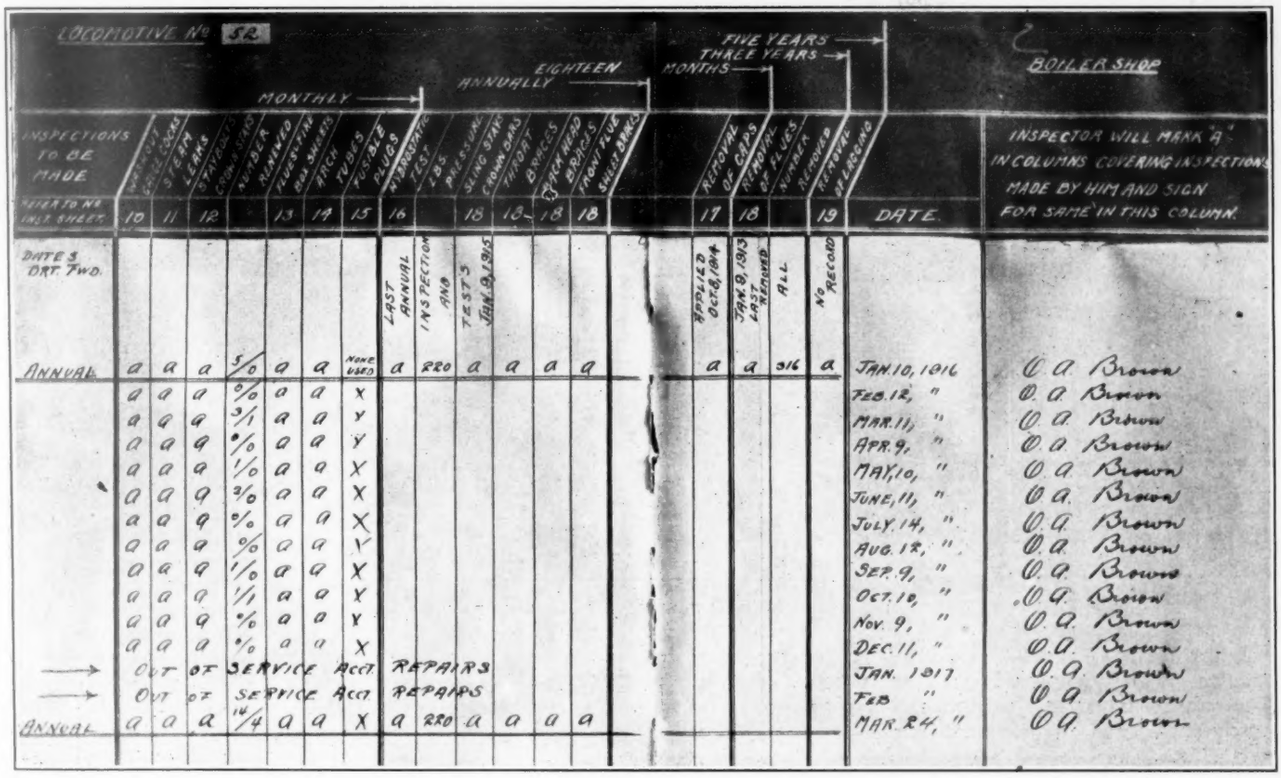
1. A basis upon which inspections shall be made.
2. Competent inspectors.
3. A system that shall anticipate required inspections.
4. A record of inspections that have been made.

Since the Interstate Commerce Commission has been given authority over the entire locomotive, and has, with the assistance of railway officers, formulated a set of rules and instructions governing these inspections, it will be granted that these rules and instructions shall be the accepted basis upon which the inspections shall be made.

The qualifications of a competent inspector have been quite thoroughly discussed in previous issues of this publication. It is the purpose of this article to describe a system of anticipating required inspections and recording them in such a manner that it will be evident on what date they will be again required. A brief study of the rules and instructions referred to above, reveals the fact that there are certain things to be done at stated intervals of time, but as these intervals vary for the different appurtenances of the locomotive, the matter becomes somewhat complicated.

At the point where this system has been in effect since January 1, 1916, we are maintaining only 21 locomotives, and as the inspectors, therefore, have other duties beside inspection, it was found advisable to classify them under the name of the department to which they are attached. There are four inspectors; one boiler inspector, two back shop inspectors and one enginehouse inspector. Each inspector is provided with a desk, stationery, and a copy of "Rules and Instructions for the Inspection and Testing of Locomotives and Tenders."

A copy of special instructions issued by the master mechanic, which cover, in a condensed form, the time for inspections and methods to be employed in making the inspections


LOCOMOTIVE No. 52

MONTHLY → ANNUALLY → EIGHTEEN MONTHS → THREE YEARS → FIVE YEARS

BOILER SHOP

INSPECTIONS TO BE MADE	Fire doors, grate doors	Steam leaks	Stripped connections	Number	Number removed	Tube sheets	Ash pan	Tubes	Flue sheet plugs	Hydrostatic test	Lubricator	Pressure	Staybolts	Crown bars	Throat	Braces	Crown sheet	Front flue sheet	Sheet arches	Removal of caps	Removal of flues	Number	Removal of arches	DATE	INSPECTOR WILL MARK "A" IN COLUMNS COVERING INSPECTIONS MADE BY HIM AND SIGN FOR SAME IN THIS COLUMN.
REFER TO NO. ON INSP. SHEET	10	11	12		13	14	15		16			18	18	18	18		17	18		19				
DATE S. OUT. TWO.									LAST ANNUAL INSPECTION AND TEST'S JAN. 9, 1915								APPLIED OCT. 4, 1914	JAN. 9, 1913 LAST RENEWED	ALL	NO RECORD				
ANNUAL	a	a	a	5/6	a	a	NONE USED	a	RRO	a	a	a	a				a	a	316	a	JAN. 10, 1916	O. A. Brown		
	a	a	a	6/6	a	a	X														FEB. 12, "	O. A. Brown		
	a	a	a	3/4	a	a	Y														MAR. 11, "	O. A. Brown		
	a	a	a	6/6	a	a	Y														APR. 9, "	O. A. Brown		
	a	a	a	1/6	a	a	X														MAY, 10, "	O. A. Brown		
	a	a	a	3/6	a	a	X														JUNE, 11, "	O. A. Brown		
	a	a	a	5/6	a	a	X														JULY, 14, "	O. A. Brown		
	a	a	a	5/6	a	a	Y														AUG. 12, "	O. A. Brown		
	a	a	a	1/6	a	a	X														SEP. 9, "	O. A. Brown		
	a	a	a	1/4	a	a	Y														OCT. 10, "	O. A. Brown		
	a	a	a	5/6	a	a	Y														NOV. 9, "	O. A. Brown		
	a	a	a	5/6	a	a	X														DEC. 11, "	O. A. Brown		
→	OUT OF SERVICE ACCT							REPAIRS													JAN. 1917	O. A. Brown		
→	OUT OF SERVICE ACCT							REPAIRS													FEB. "	O. A. Brown		
ANNUAL	a	a	a	1 1/4	a	a	X	a	RRO	a	a	a	a								MAR. 24, "	O. A. Brown		

Fig. 1—Page of Boiler Inspector's Record Book

The qualifications of a competent inspector have been quite thoroughly discussed in previous issues of this publication. It is the purpose of this article to describe a system of anticipating required inspections and recording them in such a manner that it will be evident on what date they will be again required. A brief study of the rules and instructions referred to above, reveals the fact that there are certain things to be done at stated intervals of time, but as these intervals vary for the different appurtenances of the locomotive, the matter becomes somewhat complicated.

At the point where this system has been in effect since January 1, 1916, we are maintaining only 21 locomotives, and as the inspectors, therefore, have other duties beside inspection, it was found advisable to classify them under the name of the department to which they are attached. There are four inspectors; one boiler inspector, two back shop inspectors and one enginehouse inspector. Each inspector is provided with a desk, stationery, and a copy of "Rules and Instructions for the Inspection and Testing of Locomotives and Tenders."

A copy of special instructions issued by the master mechanic, which cover, in a condensed form, the time for inspections and methods to be employed in making the inspections for which he is responsible, is framed and screwed to the wall just above each inspector's desk. These special instructions were issued with the inception of the new rules, in order that each inspector should acquire a knowledge of just what part of the work was assigned to him, and also to enable him to become thoroughly familiar with his duties in as short a time as possible. They have also proved valuable for reference and will serve as a guide for new inspectors. The accompanying tables show the form of these instructions as issued to the different inspectors. The numbers to the left of the items under the heading, "Time of Inspections and Tests," refers to the numbered descriptions under the heading.

"Methods of Inspections and Tests," where the methods to be employed are concisely stated. Each inspector is also provided with a record book for recording inspections made. Fig. 1 shows a page of the boiler inspector's book; Fig. 2 a page of the back shop inspector's book, and Fig. 3 a page of the enginehouse inspector's book.

It will be observed that each locomotive is given a page in each book, and that when the three books are brought together they present a complete record of each locomotive for a period of two and one-half years. By increasing the number of lines this period may be extended as desired. By making the book on the loose-leaf system a complete record of any locomotive can be removed from the book should it be desired to keep the record of this locomotive at some other point. Data is secured from these books for the office records, consisting of a card index which will not be described.

Water conditions in this locality being exceptionally good, it is seldom found necessary to wash out the boilers more frequently than once a month. A locomotive boiler washout sheet is issued on the first day of each month, one copy posted on a board provided for the purpose and one copy delivered to each inspector. This list shows the date upon which each locomotive is to be held for washout and therefore upon which all required inspections for the month shall be made. Locomotives out of service are so listed on the sheet.

Upon receiving this list the inspector finds, for example, that locomotives No. 3 and No. 30 are to be held for washout the following day. He turns to locomotive No. 3 and locomotive No. 30 in his record book and it is evident at a glance just what the required inspections will be. When these inspections and tests are completed and recorded, he checks off the locomotive numbers on his washout sheet and at the same time ascertains what the next locomotive will be and the date on which it is to be held, and proceeds as before.

When all locomotives have been checked off the washout sheet the books are delivered to the master mechanic's office, where they are checked for possible errors and the data is transferred to the office record. In going over the books, if any other than the regular monthly inspections are required the following month, two heavy lines are drawn to the heavy vertical lines which designate what the requirements are. This will be noted clearly by referring to Figs. 1, 2 and 3. This informs the inspector just what is required and the method becomes simple, accurate and sure.

In making out the Federal report the advantages of the record books are evident, as the dates of previous hydrostatic test, lagging removal, flexible staybolt cap removal, steam gage test, air gage test, safety valve test, removal of flues, main reservoir test, and, in fact, all required information is before the inspector under his own signature. After the record books are checked and underlined as described above a copy of the locomotive boiler washout sheet for the new month is inserted in each book and they are returned to the inspectors.

The system has proved to be a most valuable aid in eliminating errors in the Federal reports and in reducing the number of annoying incidents resulting from inefficient and irregular inspection.

Special Instructions for Boiler Inspectors

1. Inspections will be made on the same day that the engine is held in for washout. (See locomotive boiler washout sheet.)
2. Results of inspections will be recorded in the book provided, immediately after inspection.
3. Boiler inspectors must be conversant with "Rules and Instructions for the Inspection of Locomotives and Tenders," particularly rules No. 9 to No. 53 inclusive.
4. Boiler inspectors will be required to make such inspections, tests and repairs as are required to answer questions No. 10 to No. 18 inclusive on the monthly report and questions No. 1 to No. 21 in the annual report. The most important requirements are as follows:

Time of Inspections and Tests

Monthly	Annually	18 Months	3 Years	5 Years
10. Washout, gage cocks and water glass cock spindles.	16. Hydrostatic tests and all monthly inspections.	17. Removal of caps from flexible staybolts, and all monthly inspections.	18. Flue removal and all annual inspections and tests.	19. Lagging, removal, and all annual inspections and tests.
11. Steam leaks.				
12. Staybolts and crown stays.				
13. Flues and fire box sheets.				
14. Arch and water bar tubes.				
15. Fusible plug.				

Methods of Inspections and Tests

10. Boiler Washout—Gage cock and water glass cock spindle—every month.

Method: All boilers shall be thoroughly washed out and graphite compound applied as directed. The spindles of all gage cocks and water glass

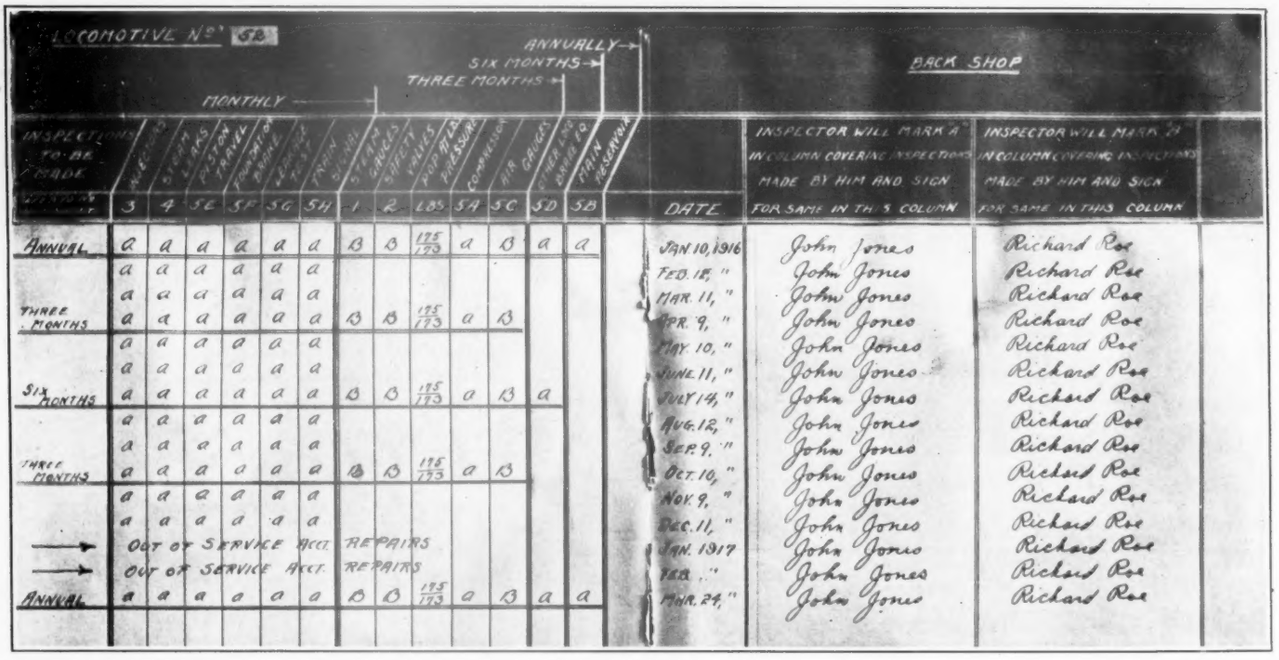


Fig. 2—Page of Back Shop Inspector's Book

cocks shall be removed and cocks thoroughly cleaned of scale and sediment.

11. Steam Leaks—Every month.

Method: All steam leaks shall be repaired.

12. Staybolts and Crown Stays—Every month.

Method: Staybolts shall be tested by hammer after the water is drained from the boiler.

13. Flues and Firebox Sheets—Every month.

Method: Condition of all flues and firebox sheets shall be noted and all leaks and cracks repaired.

14. Arch Tubes and Water Bar Tubes—Every month.

Method: Condition shall be noted and tubes shall be kept free from scale and sediment.

15. Fusible Plug—None used.

16. Hydrostatic Test—Every year.

Method: Boiler shall be subjected to hydrostatic pressure 25 per cent above working steam pressure.

17. Removal of Caps from Flexible Staybolts—Every 18 months.

Method: Caps shall be removed and bolts thoroughly inspected.

18. Removal of Flues—Every three years.

Method: All flues shall be removed and thoroughly cleaned and the weight noted. Interior of boiler shall be thoroughly cleaned and all scale and sediment removed. The entire interior of the boiler shall then be examined for cracks, pitting, grooving or indications of overheating, and for damage where mud has collected or heavy scale formed. The edges of plates, all laps, seams and points where cracks and defects are likely to develop, shall be given especially minute examination. All braces and

LOCOMOTIVE No. 52

THREE MONTHS MONTHLY →

ENGINE HOUSE

INSPECTIONS TO BE MADE	DRAFT AND BUFFER GEAR	DRIVING GEAR	RUNNING GEAR	TENDER	DRAFT GEAR		
REFER TO NO. INST. SHEET	6A	7	8	9	6B	DATE	INSPECTOR WILL MARK "A" IN COLUMN COVERING INSPECTIONS MADE BY HIM AND SIGN FOR SAME IN THIS COLUMN
ANNUAL	a	a	a	a	a	JAN 10, 1916	A. Smith
	a	a	a	a		FEB 12, "	A Smith
	a	a	a	a		MAR 11, "	A Smith
THREE MONTHS	a	a	a	a	a	APR 9, "	A Smith
	a	a	a	a		MAY 10, "	A Smith
	a	a	a	a		JUNE 11, "	A Smith
THREE MONTHS	a	a	a	a	a	JULY 14, "	A Smith
	a	a	a	a		AUG 12, "	A Smith
	a	a	a	a		SEP 9, "	A Smith
THREE MONTHS	a	a	a	a	a	OCT 10, "	A Smith
	a	a	a	a		NOV 9, "	A Smith
	a	a	a	a		DEC 11, "	A Smith
→	OUT OF SERVICE ACCT. REPAIRS					JAN 1917	A Smith
→	OUT OF SERVICE					FEB "	A Smith
ANNUAL	a	a	a	a	a	MAR 24, "	A Smith

Fig. 3—Page of Enginehouse Inspector's Book

stays shall be taut, pins secured in place, and each shall be in condition to support its proportion of the load.

19. Removal of Lagging—Every five years.

Method: Jacket and lagging shall be removed and exterior of boiler thoroughly inspected.

SPECIAL INSTRUCTIONS FOR BACK SHOP INSPECTORS

1. Inspections will be made upon the same day that the engine is held in for washout. (See locomotive boiler washout sheet.)

2. Results of inspections will be recorded in the book provided, immediately after inspection.

3. Back shop inspectors must be conversant with "Rules and Instructions for the Inspection and Testing of Locomotives and Tenders," particularly rules No. 6 to No. 21 inclusive. A copy of these rules will be provided each inspector, and if the inspector is in doubt as to their meaning, explanation will be made by the master mechanic.

4. Back shop inspectors will be required to make such inspections, tests and repairs as are required to answer questions No. 1 to No. 5 inclusive on monthly report and questions No. 22 to No. 27 on annual report. The most important requirements are as follows:

Time of Inspections and Tests

Monthly	Each 3 Months	Each 6 Months	Annually
3. Injectors.	1. Steam gage.	5D. Other locomotive brake equipment and all monthly and tri-monthly inspections and tests.	5B. Main reservoir and all monthly, tri-monthly and semi-annual inspections and tests.
4. Steam leaks.	2. Safety valve.		
5E. Piston travel.	5A. Compressor.		
5F. Foundation brake.	5C. Air gage and all monthly inspections and tests.		
5G. Leakage test.			
5H. Train signal.			

Methods of Inspections and Tests

1. Steam Gage Test—Every three months.

Method: Steam gages shall be compared with an accurate test gage or dead weight tester, and gages found inaccurate shall be corrected before being put into service.

2. Safety Valve Test—Every three months.

Method: Safety valves shall be set to pop at pressures not exceeding six pounds above working steam pressure. When setting safety valves, two steam gages shall be used, one of which must be so located that it will be in full view of the person engaged in setting such valves; and if the pressure indicated by the gage varies more than three pounds they shall be removed from the boiler, tested and corrected before the safety valves are set. Gages shall in all cases be tested immediately before the safety valves are set or any change made in the setting. When setting safety valves the water level in the boiler shall not be above the highest gage cock.

3. Injectors—Every month (also before each trip).

Method: Injectors shall be in such condition that they will deliver water to the boiler without excessive overflow and all boiler checks, delivery pipes, feed water pipes, tank hose and tank valves shall be in good condition, free from leaks and from foreign substances that will obstruct the flow of water.

4. Steam Leak Inspection—Every month.

Method—All valves, fittings and other appurtenances of boiler, located in the cab, shall be inspected each month, and if leaking or otherwise not in safe or suitable condition for service, shall be repaired before engine is again put in service.

5. Brake and Signal Equipment.

A.—Compressor Test—Every three months.

Method: All compressors shall be tested for capacity by orifice test. The diameter of orifice, speed of compressor and the air pressure to be maintained is to be as follows:

Size of compressor and make	Single strokes per minute	Diameter of orifice	Air pressure maintained
Westinghouse 9½ in.	120	11/64 in.	60 lb.

Note: Air pumps overhauled and kept on rack shall be considered as *tested on date applied to locomotives.*

B.—Main Reservoir Test—Every 12 months.

Method: Subjected to hydrostatic pressure not less than 25 per cent above the maximum allowed air pressure. The hydrostatic pressure shall be 150 lb. per square inch.

C.—Air Gage Test—Every three months.

Method: Air gages shall be compared with dead weight tester and gages found incorrect shall be repaired before they are returned to service.

D.—Other Locomotive Brake Equipment—Every six months.

Method: All equipment shall be cleaned and lubricated and the date shall be stencilled on metal tag as per rule No. 11, Rules and Instructions for Inspection and Testing of Steam Locomotives and Tenders.

1. Distributing or control valves.
2. Triple valves.
3. Reducing valves.
4. Straight air double check valves.
5. Dirt collectors.
6. Brake cylinders.

E.—Fisten Travel Test—Every month.

Method: The maximum piston travel when the locomotive is standing shall be as follows:

Driving wheel brake..... 6 in.
Engine truck brake..... 8 in.
Tender brake ..... 9 in.

F.—Foundation Brake Gear Inspection—Every month.

Method: All parts of brake gear shall be in safe and suitable condition as per Rule 13, and no part shall be less than 2½ in. above the rails.

G.—Leakage Test—Every month.

1. Main reservoir and relating piping leakage shall not exceed 9 lb. in 3 min.
2. Brake pipe leakage shall not exceed 5 lb. per min.
3. Brake Cylinder Leakage: With a full service application from maximum brake pipe pressure, and with communication to the brake cylinders closed, the brakes on locomotive and tender shall remain applied not less than 5 minutes.

H.—Train Signal System Test—Every month.

Shall be tested and known to be in safe and suitable condition.

SPECIAL INSTRUCTIONS FOR ENGINEHOUSE INSPECTORS

1. Inspections will be made upon the same day that the engine is held in for washout. (See locomotive boiler washout sheet.)

2. Results of inspections will be recorded in the book provided, immediately after inspection.

3. Enginehouse inspectors must be conversant with "Rules and Instructions for the Inspection of Locomotives and Tenders," particularly rules No. 22 to No. 58 inclusive. A copy of these rules will be provided each inspector and if the inspector is in doubt as to the meaning, explanation will be made by the master mechanic.

4. Enginehouse inspectors will be required to make such inspections, tests and repairs as are required to answer questions No. 6 to No. 9 inclusive on the monthly report and questions No. 28 to No. 32 inclusive on the annual report. The most important requirements are as follows:

Time of Inspections and Tests

Monthly	Each 3 Months	Each 6 Months	Annually
6A. Draw gear.	6B. Draw gear, and all monthly inspections.	All monthly and tri-monthly inspections.	All monthly, tri-monthly and semi-annual inspections.
7. Driving gear.			
8. Running gear.			
9. Tender.			

Methods of Inspections and Tests

6A. Draw Gear and Draft Gear—Every month.

All parts shall be inspected and shall not be returned to service unless in safe and suitable condition for service.

6B. Draw Gear Between Locomotive and Tender; Inspection—Every three months.

Method: Pins and drawbar shall be removed and carefully examined and not returned if not found safe and suitable for service.

7. Driving Gear Inspection—Every month.

A.—Crossheads shall not have more than ¼ in. vertical nor 5/16 in. lateral play between the guides.

B.—Guides shall be securely fastened; all nuts shall be kept tightened.

C.—Pistons and piston rods shall be examined for cracks and defects each time they are removed.

D.—Rods—Side and Main.—All cracked or defective side rods shall be removed from service. Lateral motion of rods on crank pins shall not exceed ¼ in.

On Road Locomotives: Bore of main rod bearings shall not exceed diameter of pin more than ⅛ in. Bore of side rod bearings shall not exceed pin diameter more than 5/32 in. on main pin, nor more than 3/16 in. on other pins.

On Yard Locomotives: Bore of main rod bearing shall not exceed diameter of pin more than ⅛ in. at the front end, nor more than 5/32 in. at the back end. Bore of side rod bearings shall not exceed diameter of pin more than 3/16 in.

8. Running Gear Inspections—Every month.

A.—Driving boxes shall not have more than one shim between box and bearing.

B.—Lateral motion shall not exceed the following limits:

Engine truck wheels (swing centers)	1 in.
Engine truck wheels (rigid centers)	1½ in.
Trailing truck wheels	1 in.
Driving wheels	¾ in.

C.—Pilots and Plows:

Minimum clearance above rails	3 in.
Maximum clearance above rails	6 in.

D.—Spring Rigging:

Springs or rigging with following defects shall be repaired or renewed: One long leaf or two or more short leaves broken; leaves working in band; broken coil springs; broken driving box saddle, equalizer, hanger, bolt or pin.

E.—Trucks: Male center plate shall extend into female center plate not less than ¾ in.

F.—Wheels: See rules and use limit gage.

9. Tender Inspection—Every month.

A.—The difference between the height of the deck on the tender and the deck of the locomotive shall not exceed 1¼ in.

B.—Width of gangway between locomotive and tender while standing on straight track shall not be less than 16 in.

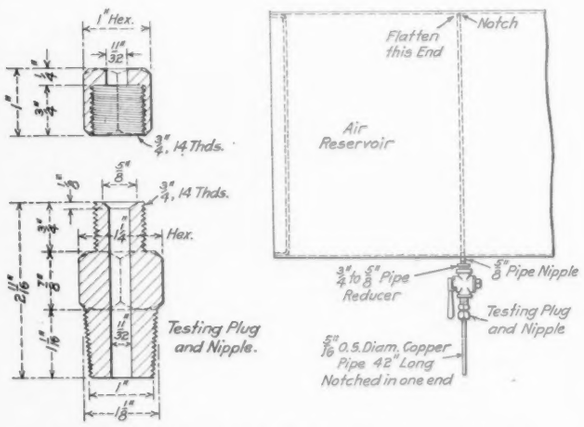
C.—Interior of tanks shall be inspected each month.

D.—Trucks: Male center plate shall extend into female center plate not less than ¾ in.

REMOVING AIR POCKETS FROM RESERVOIRS

BY W. H. HAUSER
Mechanical Engineer, Chicago & Eastern Illinois, Danville, Ill.

Paragraph 8 of the Rules and Instructions for the Inspection and Testing of Locomotive Boilers, as approved by the Interstate Commerce Commission, October 11, 1915, requires that main air reservoirs shall be subjected to hydrostatic



Method of Removing Pocketed Air for a Reservoir

pressure not less than 25 per cent above the maximum allowed air pressure, before being put into service and at least once each 12 months thereafter.

There are in service numerous air reservoirs with their axes horizontal, which have the air pipes tapped into the center of the heads of the reservoirs. There is an outlet at the bottom for drainage, but there is no outlet at the top by which the air can escape when filling the reservoir for the hydrostatic test. A hole could be drilled and a plug inserted to allow the removal of this pocketed air, but if this is done it adds another opening for air leaks and places the plug in a very inconvenient position, especially if it becomes necessary to apply one on the road through the plug blowing out. In the method shown in the sketch a copper tube is inserted in the reservoir. This tube has a notched edge by which the air is all blown out and water allowed to fill the entire reservoir. This is very simple, and the apparatus can be bought at a nominal cost.

GETTING RESULTS FROM A BIG ENGINE TERMINAL*

BY GEORGE COOK
Roundhouse Foreman, Northern Pacific, Ellensburg, Wash.

Efficiency in enginehouse management is appraised by results. By results we mean a minimum number of engine failures, economy and lack of friction with the transportation department and with employees under the enginehouse foreman. This is obtained through system. System applied to enginehouse management is governed by conditions at the place considered, and includes the method of handling the engines from the incoming switch to the outgoing switch, the consumption of material, the condition of the shop machinery and tools, the treatment of mechanics and laborers, and the condition of buildings and grounds. A system or regular order of procedure should be applied to every act about an engine terminal.

At a point where engines are needed as soon as they are available there should be as little delay as possible between the time they are placed on the incoming track and the time they are put in the house. If conditions will permit this will include supplying them with fuel, sand, water and having grates and ashpans cleaned.

Book records should be kept of all inspection and other work performed. Bearings and packing should all be examined at the end of each trip or day's work, not by putting a hand on the hub of the wheel or the top of the box, but by dropping the cellar and making certain that the packing is properly lubricated and against the journal. Tank and trailer oil box lids should be raised and the packing hook used to reach in and feel if the packing is properly distributed from dust guard to collar. All standard practices should be complied with to the letter. Power is most efficient when each part is maintained in a serviceable condition, and the fact that a stitch in time saves nine and often an engine failure, should never be lost sight of by a foreman. If a certain class of power on any district is giving trouble, each foreman should make an effort to be the first to locate and eliminate the cause. A clean engine is more easily inspected than a dirty one, the working parts last longer. Furthermore the public appreciates traveling on a road which has its locomotives looking bright and clean.

A shop machine or tool in good serviceable condition is a revenue earner; one in poor and unsafe condition is a liability. Much money and energy is wasted in enginehouses through poor tool equipment.

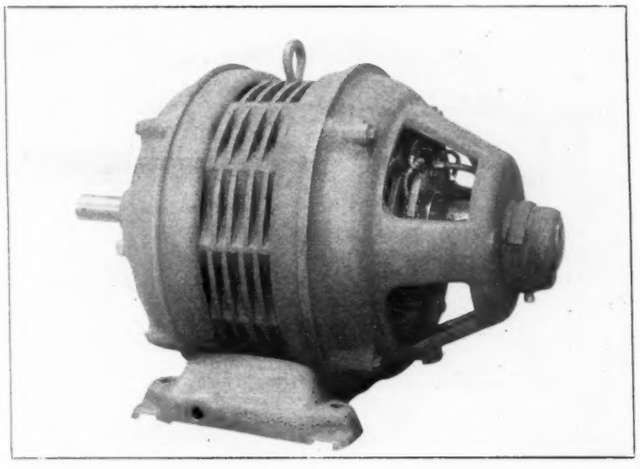
Specialize the work as far as conditions will permit, but have a substitute for every position. Promote the laborers when possible, and a better class of men can be kept in enginehouses. This can be arranged by advancing them to fireman, or having an agreement with the car foreman to draw his laborers from the enginehouse force.

*Entered in the Enginehouse Competition.

New Devices

INDUCTION MOTOR FOR TURNTABLES AND TRANSFER TABLES

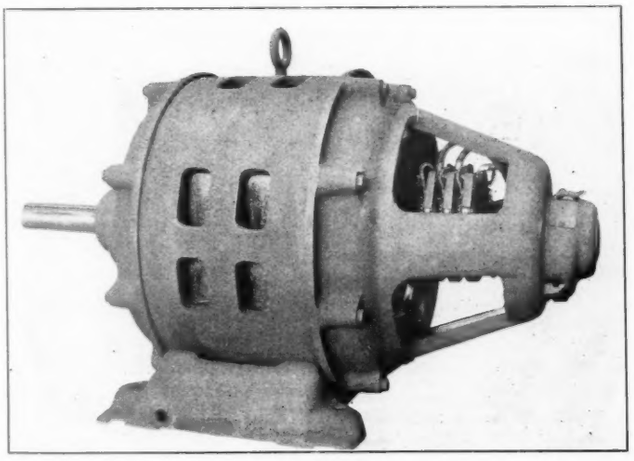
A line of slip ring induction motors for severe intermittent service at varying speeds has been developed by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. These motors are especially designed for use on cranes, draw bridges, roller lift bridges, railway turntables and



Ten Horsepower Slip Ring Induction Motor with Laminated Frame

transfer tables, and are furnished in sizes from 1½ hp. to 200 hp. They are designed for operation on two or three phase circuits of 25 or 60 cycles frequency at voltages of 220 or 440.

The frames of the larger sizes are made of rolled open-



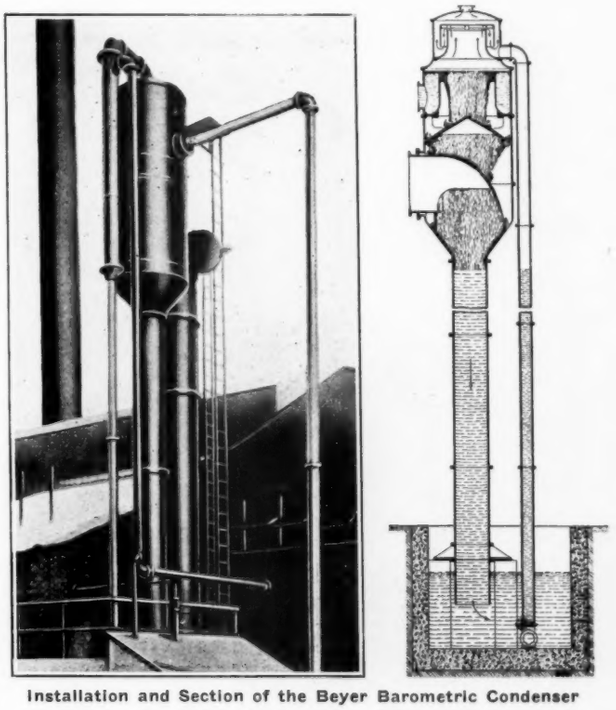
A 75-hp. Motor with Rolled Steel Frame

hearth steel, one of the illustrations showing a 75-hp. motor with this type of frame. On the smaller sizes the frames are made of steel laminations which are riveted together between forged steel end shields. The brackets are of cast iron with reinforcing ribs to insure perfect alinement of the bearings. The bearings are self-oiling of the oil-ring type and are of large size. The steel brush holders are supported by the brackets from which they are insulated and the brackets are open to permit the brushes to be easily inspected and renewed.

The rotor is small in diameter which reduces the fly-wheel effect to a minimum. This feature together with the perfect balance and secure attachment of the winding makes these motors especially suitable for frequent starting, stopping and reversing. The shaft can be removed from the rotor without disturbing the winding, the construction being such that in case of accident repairs can be made quickly. The weight and over-all dimensions have been kept to the minimum consistent with the strength required.

BEYER BAROMETRIC CONDENSER

The Ingersoll-Rand Company, New York, is now furnishing complete steam condensing plants for all service conditions. This equipment includes the Beyer barometric condenser, for which the company has secured the patent rights.



Installation and Section of the Beyer Barometric Condenser

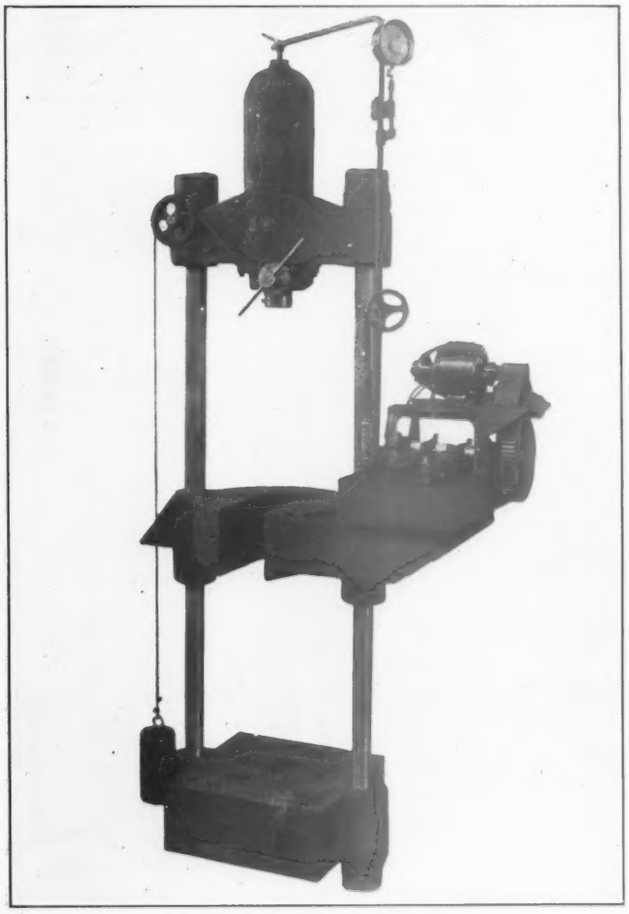
This condenser is of the counter-current type, in which air and cooling water flow in opposite directions. The steam inlet is at the bottom of the condensing vessel, the water inlet above and the air removal opening at the top. The sheets of cooling water, overflowing the pool at the inlet point, meet the entering steam. The two are brought into intimate contact by conical baffle plates assisting the water

to absorb to its full capacity the latent heat of the steam. The non-condensable air liberated in the condensing action rises through the falling water to the removal point at the top, being cooled to practically the temperature of the incoming water. Ample opportunity is given for the removal of the air content of the water before it mixes with the steam. This is not only facilitates the mixing process, but permits the removal of air and vapor at a comparatively low temperature, which is an advantage, as the reduced volume saves in vacuum pumpage horsepower.

The steam inlet is of large diameter to secure low velocity and is hooded in such a way as to discharge the steam into the center of the condensing vessel. The air removal opening is protected by a self-draining baffle and trap, which it is claimed positively prevents water being carried over into the vacuum pump. The hot waste water is discharged through the self-draining tail pipe. This pipe straddles the hot well and supports the condenser.

HYDRAULIC FORCING PRESS

The hydraulic press shown in the engraving is a new design of inverted forcing press recently brought out by the Hydraulic Press Mfg. Company, Mount Gilead, Ohio. This is a double purpose press, being intended for two distinct forcing operations. It is constructed in two parts, the upper part having a maximum pressure capacity of 100 tons and the lower part 50 tons.



Inverted Forcing Press with Motor-Driven Pump

The press was primarily designed for use in applying locomotive piston rods to the pistons, and also for removing the pistons from the rods, but it is also adaptable to a wide range of miscellaneous forcing work. In forcing on a piston, it is set on the lower base with the rod passing up through the press base proper, the pressure then being applied from the end of the piston rod, forcing it into the piston. When the press is used for forcing the piston off the rod, the piston, with the rod, is hung on the press base proper and the pressure applied from the end of the rod, forcing the rod out of the piston. More pressure is required for the latter operation and the upper part of the press is thus designed for a maximum pressure of 100 tons, while the lower portion is designed for a maximum pressure of only 50 tons.

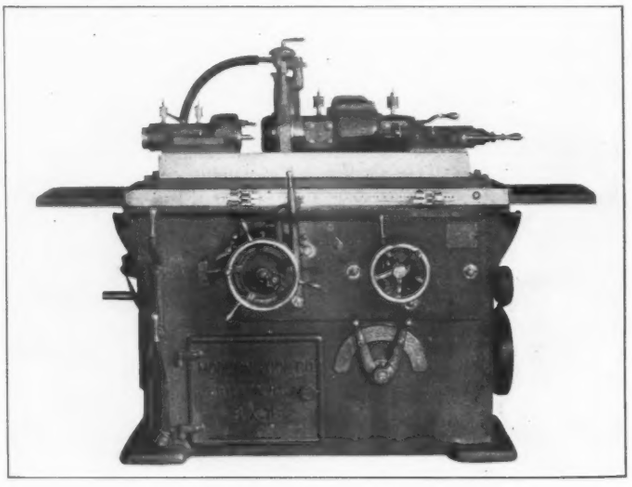
The usual method of installing this machine is to erect it so that the base of the press proper is just above the floor level, the lower parts being under the floor. It is self-contained, the pressure being furnished by a direct motor-driven horizontal double-plunger pump with double gear reduction. A tee screw hydraulic operating valve controls the pressure from this pump to the press cylinder.

The diameter of the press ram is 10 in. It has a run of 22 in. and is equipped with a rack and pinion attachment for raising or lowering the ram upon the work. Thus various lengths of work may be admitted to the press and the pressure instantly applied at the first stroke of the pump. The daylight space for the upper portion of the press is 36 in. and for the lower part 50 in., making the total daylight or working space 86 in. Steel is used for all the principal castings; cold rolled steel shafting 4 in. in diameter is used for the strain rods.

GRINDING MACHINE

The Modern Tool Company, Erie, Pa., has added to its line of self-contained grinding machines two additional sizes, an 8 in. by 18 in. and an 8 in. by 30 in. With the exception of the center distances and the wheel drive on the 8 in. by 30 in. the machines are similar.

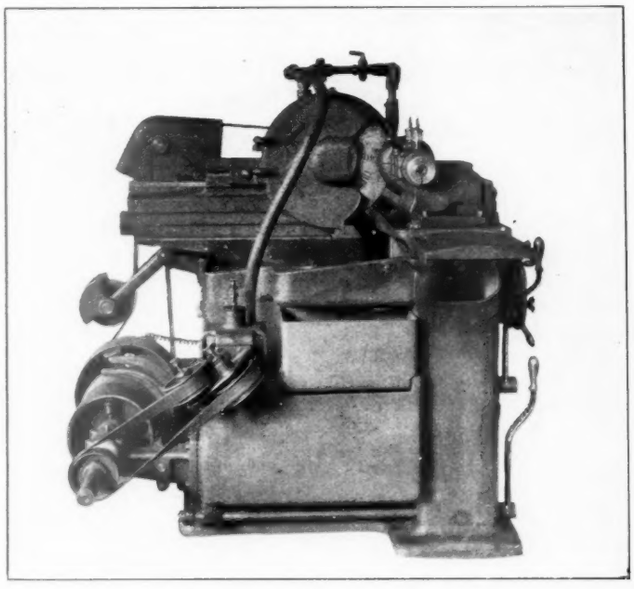
Economy of floor space, compactness, ease of operation, and comparative simplicity of mechanism are distinguishing features of these machines. All operating levers are concentrated on the front of the machine, and there is nothing extending above the wheel stand, all mechanisms being contained within the machine. The machines are essentially manufacturing grinders for straight or taper cylindrical work in quantities. The bed is a one-piece casting, rigidly braced. V and flat guides are used throughout on the sliding table, swivel table and under the wheel stand. The base rests upon three points.



Front View of the 8-in by 18-in Machine

The standard wheel spindle is 2¼ in. in diameter running in phosphor bronze bearings 6¼ in. long and driven by a belt 4 in. wide. For heavy work, the wheel spindle is made 3¼ in. in diameter. The wheel stand pile is bolted to the bed of the machine and is of generous proportions. The wheel center is of large diameter, has a long bearing in the spindle, and will take any of the recognized standard grinding wheels. Wheels used on the standard machines are 16 in. diameter up to 3 in. face; wheels used on the heavy drive are 18 in. up to 4 in. face.

The table drive is of a simplified type, eliminating what was formerly known as the table transmission. This drive consists of a single unit contained in the bed of the machine, which is a combination of table drive and transmission.



End View, Showing Main Drive and Pump

All-steel spur gears are used for the reversing mechanism. The power table traverse is controlled by a lever immediately to the left of the table hand wheel, which provides for starting or stopping the table at any point in its stroke. When the table is under power the hand wheel is automatically disengaged, and when the power is removed the hand wheel is automatically engaged for traversing the table by hand. There are four table feeds, derived from a single unit gear box, and controlled by a lever at the right immediately below the table hand wheel.

The automatic cross feed is positive in its action and is simplified without losing any of its features. This can be set for a reduction of any amount from .0005 in. to .005 in. at either or both ends of the table reverse. This latter feature is especially advantageous when grinding against a shoulder. The feed is automatically thrown out when work is ground to size and a positive stop is provided for use when feeding by hand. The cross feed hand wheel is graduated in .0005 in. in plain view of the operator. The headstock is of a new design, being driven from a shaft under the sliding table. This shaft is driven by a pulley which is carried in a bracket on the bed, on which power is taken from the gear box.

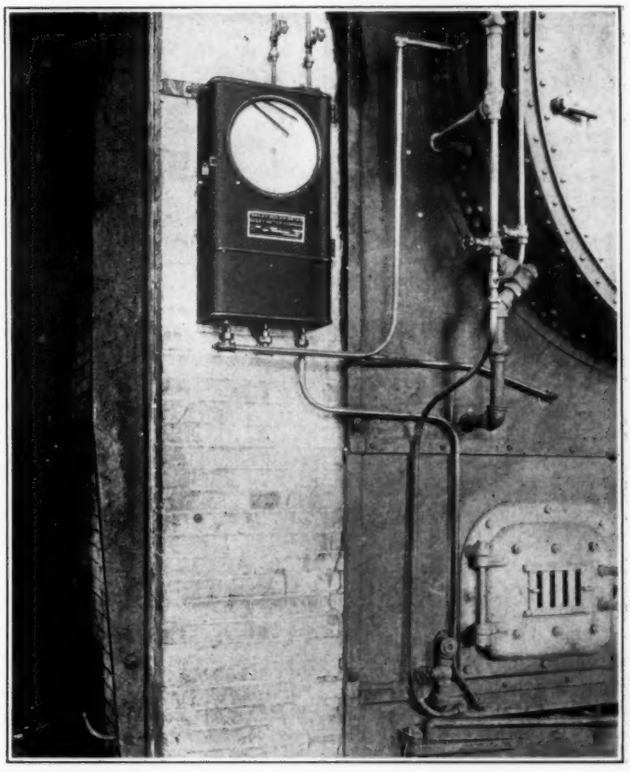
The wheel truing device is mounted on the footstock and is adjustable to all diameters within the range of the machine so that the wheel can be trued without removing the work from the centers. The pump is of the fan type and revolves in a horizontal plane and is kept immersed so that it is constantly primed and no packing is required.

The machines have eight work speeds from 26 to 390 r.p.m., and four table feeds from 22 in. to 104 in. per minute. The feeds and speeds are entirely independent of each other. The new sizes have the single constant speed drive used on the larger machines, which reduces the cost when equipping the machines with motors.

BAILEY BOILER METER

The Bailey boiler meter, which is made by the Bailey Meter Company, Boston, Mass., is a combination of three separate meters in one casing, each drawing its own record in a distinctive color on a 12 in. chart. This meter records the rate of steam output from the boiler, the rate of air flow through the furnace, and the condition of the fuel bed. It also correlates and compares these factors in such a manner that any fireman can readily understand the readings and inform himself as to any needed change in the furnace or draft conditions.

The steam flow is recorded by a pen drawing a red record in the center section of the chart, the graduations being in per cent of the boiler's rated capacity on a uniform scale. The air flow is recorded by a pen drawing a blue record. This pen is located so that it travels immediately in front of and records just ahead of the steam flow. It is operated by the draft differential between the firebox and the uptake, but

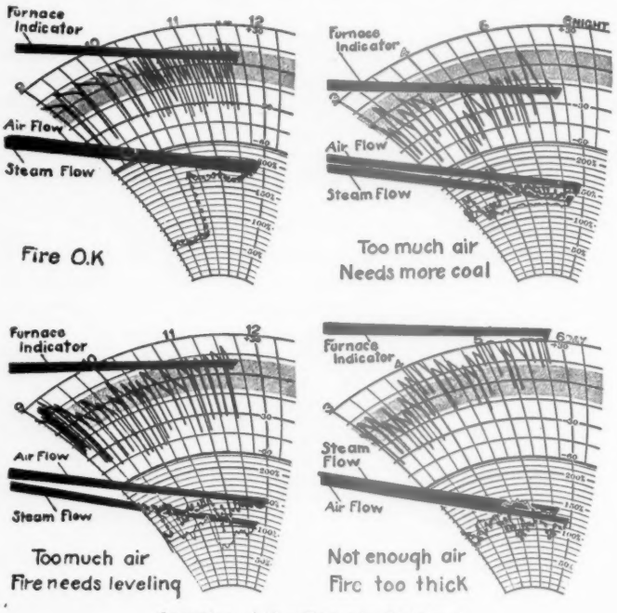


Bailey Meter in Position

instead of reading in terms of draft it reads in terms of steam output. In other words, it gives the same reading and draws a coincident record with the steam flow so long as the right amount of air is used for combustion. If the air flow reads more than the steam flow it shows too much air and corresponds to low carbon dioxide; if it reads less than the steam flow it means insufficient air and loss due to unburned gases. This is based upon the principle that air is a fuel just as much as is coal, and a certain evaporation should be obtained per pound of air. This standard is determined for each boiler and the meter adjusted accordingly.

The furnace indicator drawing a record on the outer sec-

tion of the chart shows the conditions of the fuel bed. The fire is of the right thickness when this pen is on the shaded band, too thick when above and too thin when below. This also is adjusted to individual conditions after extensive tests have been made to determine the best kind of fire to carry. This indicator is operated by draft pressures and is in reality a measure of the resistance of the fuel bed to the flow of air. It should not be confused with the drop in draft pressure across the fuel bed, for it includes the draft pressure in the uptake as well as the firebox and ash pit in such a way as to eliminate the effect due to the intensity of the draft or the rate of flow of air and responds only to changes in condition



Samples of the Records Obtained

of the fuel bed. That is, the pen does not move when the damper opening or draft pressure varies from maximum to minimum unless the fire changes, but when the fire burns too thin or develops holes, the recorder shows it regardless of the intensity of the draft.

Every part of the meter responds promptly to changes in any of the operating conditions. In a hand fired furnace it plainly shows each opening of the fire door, cleaning of the fire, etc.

SPECIAL GLASS TO PREVENT ACCIDENT

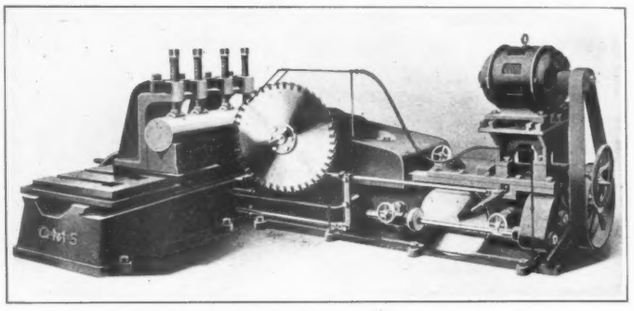
The Hires Turner Glass Company, Philadelphia, is furnishing what is called Superglass for use in moving vehicles. It is intended to prevent accidents due to flying broken glass. It is made up of two pieces of polished plate glass between which is a sheet of celluloid of the proper shade for the uses to which it might be subjected. The glass and celluloid are welded together under high temperature and pressure. If a sheet of this glass is struck a powerful blow by some hard missile, it is claimed that it will only crack into hair lines, with no flying glass or splinters.

Spacing Bolt Holes in Castings.—Holes in castings should be located at a certain minimum distance from the edge of the casting. A drilled bolt hole should be located at least one and one-fourth diameter from the edge of the casting; a cored bolt hole, one and one-half diameter; a drilled rivet hole, one and three-fourths diameter; and a cored rivet hole, two diameters from the edge of the casting. —*Machinery.*

COLD METAL SAWING MACHINE

The accompanying photographs show a recent design of the O. M. S. cold metal sawing machine which has been placed on the market by the Vulcan Engineering Sales Company, Chicago.

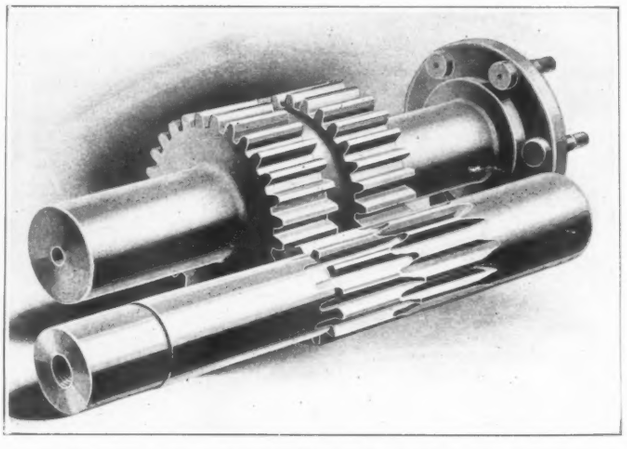
The saw and gear arbor are of hammered, open hearth, .60 carbon steel, fitted by scraping. The teeth are cut from the solid, and being staggered, back-lash and resultant chatter of the saw blade are reduced to a minimum. The saw and



Q. M. S. Cold Metal Sawing Machine

gear arbor run in hard bronze bearings. The worm is of hardened steel, and roller bearings take the end thrust. The worm wheel is of two-piece construction, having steel center with a special bronze rim. The worm and worm wheel are encased and run in grease.

The carriage is of box section construction. A spline shaft prevents the spline in the main or worm shaft coming in contact with the bronze bearings. The feed is obtained by a combination of a friction disc and gears, providing a



Staggered Tooth Construction of Saw and Gear Arbors

range of from 5/16 in. to 2½ in. per minute. The friction wheel automatically sustains the proper contact with the friction disc, insuring maximum power. The peripheral speed change is instantaneous and is arranged to run either at 30 and 50 ft. or 40 and 60 ft. per minute as desired.

All gears run in oil and the internal bearings are lubricated by oil pipes leading to the outside of the machine. An oil trough is cast around the work table and a gear pump provided for lubricating the saw table.

Darkest Guatemala.—As a result of the war, Ocos, Guatemala will lose its electric-lighting plant. About nine years ago the Kosmos liner Sesostris was beached near there, and the chief engineer arranged to supply the town with electricity, after it was decided not to refloat the ship. Now the demand for vessels has reached a point where it appears profitable to dig a canal and float the ship back to sea. —*Electrical Review.*

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WE GUARANTEE, that of this issue 8,500 copies were printed; that of these 8,500 copies, 7,744 were mailed to regular paid subscribers, 90 were provided for counter and news companies' sales, 426 were mailed to advertisers, exchanges and correspondents, and 240 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 57,600, an average of 7,200 copies a month.

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The Pennsylvania Railroad, in consequence of the destruction by fire of its large grain elevator at Baltimore, is sending trainloads of grain to the new elevator of the Western Maryland, on the south side of the harbor.

The Southern Pacific has given notice that owing to the Mexican situation all of its lines south of the border are closed and that the company is not in position to accept shipments for points in Mexico via Nogales or Naco.

According to a statement issued by the United States Geological Survey, the use of petroleum as locomotive fuel increased 18 per cent last year. It is said that 37,000,000 barrels were used as against 30,000,000 the year before. Oil fuel is used on 40 railroads in the United States.

The operation of open-top observation cars through the Royal Gorge and the Black Canyon of the Gunnison in Colorado has been resumed for the summer by the Denver & Rio Grande. All trains passing through these points by daylight have these cars.

At Princeton, N. J., an agent of the Pullman Company has been engaging students and graduates of the University for service as conductors of parlor cars, apparently to fill up the ranks for the summer resort business. It is said that the salary to be paid will be $77 a month, and that there were a large number of applicants. Those under 25 years of age were not accepted.

By direction of the Commission on Car Service of the American Railway Association a force of 20 inspectors has been organized by the secretary of the commission to develop actual violations of Car Service Rules 1 to 4, inclusive, by inspection of records as well as by field investigation. This action was authorized by the American Railway Association at its meeting on May 17.

The College of Engineering of the University of Illinois, Dr. W. F. M. Goss, dean, at the commencement on June 14, conferred 10 bachelor degrees in railway engineering, 39 in civil engineering, 43 in electrical engineering and 44 in mechanical engineering, in addition to degrees in architecture,

mining, etc., 222 in all. In addition there were conferred by the departments of engineering, 21 master's degrees, 21 professional degrees and 3 doctor's degrees.

In a fire at the Pennsylvania Railroad piers at Canton, Baltimore, Md., on the afternoon of June 13, grain elevator No. 3 was destroyed together with much other property, and a number of employees and other persons, said to be ten or more, were killed. Over 30 other persons were injured by burns and falls. The property loss is estimated at $2,000,000. The ore pier and many freight cars were destroyed and several vessels lying at the piers were badly damaged.

Will Leggins, of Thomasville, Ga., has received a medal of honor from President Wilson upon recommendation of the Interstate Commerce Commission. On November 11, 1915, a pay train of the Atlantic Coast Line was derailed in the yards at Thomasville, and Leggins employed in the shops, 300 feet distant, hearing a crash, ran to the overturned locomotive, under which was pinioned Engineman Taylor. Leggins fought his way to the injured man, shielded his body, called for a bar and extricated him. Taylor died later. Leggins' act was commended by the President in a letter accompanying the medal.

CORRECTION

In the locomotive table published on page 235 of the May, 1916, number of the *Railway Mechanical Engineer*, the Delaware & Hudson Consolidation was shown as using bituminous coal. This is incorrect, as the engine was designed and built for the burning of pulverized anthracite culm in suspension.

ORDERS FOR CARS AND LOCOMOTIVES IN JUNE

The outstanding feature regarding the orders for cars and locomotives reported during June was the buying of passenger cars, orders having been placed for 164 cars. This was more than have been ordered any month this year, with the exception of January, when 310 cars were ordered, of which 200 were subway cars for the New York Municipal Railway Corporation. It should be noted, however, that the orders for passenger cars reported during December, 1915, totaled 508. The orders for both cars and locomotives reported during the month were as follows:

	Locomotives	Freight cars	Passenger cars
Domestic	174	3,531	164
Foreign	213	2,140	...
	387	5,671	164

Among the important locomotive orders were the following:

Road	Number	Type	Builder
Chesapeake & Ohio	25	Mallet	American
	25	Mallet	Lima
Lehigh Valley	40	Santa Fe	Baldwin
	30	Pacific	Baldwin
New York Central	25	Mallet	American
Texas & Pacific	8	Santa Fe	Baldwin
Egyptian State Railways	24	Six-wheel (0-6-0)	American
French Government	100	Narrow gage	Baldwin
Russian Government	70	Narrow gage	American

The freight car orders included the following: Baltimore & Ohio, 1,000 box cars, Haskell & Barker Car Company; Canadian Government Railways, 500 box cars, Canadian Car & Foundry Company; Denver & Rio Grande, 500 box cars, Pullman Company; Southern Railway, 1,000 box cars, Lenoir Car Works; and the United Railways of Havana, 300 flat and 200 box cars, Pressed Steel Car Company; 140 flat, Standard Steel Car Company; 100 cane, 100 flat and 100 narrow gage cars, American Car & Foundry Company.

The passenger car purchases included orders placed by the Chicago & North Western for 10 baggage cars, 15 smoking cars, 24 coaches, 5 baggage and mail cars and 3 postal cars, American Car & Foundry Company; Delaware, Lackawanna & Western, 45 coaches and 10 passenger and baggage cars for suburban service, Pullman Company; New York Central, 12 multiple unit cars, Standard Steel Car Company; Pennsylvania Lines West, 10 baggage and mail cars, Pullman Company, and Texas & Pacific, 8 baggage and mail cars, American Car & Foundry Company.

FOREIGN SPECIFICATIONS FOR RAILWAY MATERIAL

With the object of placing in convenient and accessible form before those in the United States interested in or responsible for railway materials, the Bureau of Standards, Department of Commerce, in connection with its investigation of failures of railway material, has obtained, through the courtesy of the state department, copies of specifications for railway material—rails, axles, wheels, and tires—used in several European countries. These specifications are given in full, together with a digest and discussion, in Technologic Paper No. 61, just issued. The available data concerning the types and weights of foreign railway equipments together with those concerning derailments and accidents abroad, are also included in the publication. Persons interested may obtain copies of the paper, which is entitled "Foreign Specifications for Railway Material," without charge upon application to the Bureau of Standards, Washington, D. C.

MEETINGS AND CONVENTIONS

Chief Interchange Car Inspector's and Car Foreman's Association.—The annual convention of the Chief Interchange Car Inspector's and Car Foreman's Association will be held in Indianapolis, Ind., October 3, 4, and 5, 1916.

American Railway Tool Foreman's Association.—The convention of the American Railway Tool Foreman's Association will be held on August 24-26, at the Hotel Sherman, Chicago. The following subjects will be presented by the committees: Heat Treatment of Steel, Henry Otto, chairman; Special Tools for Steel Car Repairs—Devices for Reclaiming Material, J. W. Pike, chairman; Special Tools and Devices for the Forge Shop, G. W. Smith, chairman; Emery Wheels as Applied to Locomotive Repairs, A. Sterner, chairman; Jigs and Devices for Enginehouses, F. D. West, chairman.

The Traveling Engineers' Association.—The next annual convention of The Traveling Engineers' Association will be held on September 5-8, at Chicago, Ill. The following is a list of the subjects to be discussed at this meeting: Stoking and Lubricating, and Their Effect on the Cost of Locomotive Operation; Superheaters and Brick Arches on Large Locomotives; The Prevention of Smoke and Its Relation to the Cost of Fuel and Locomotive Repairs; Recommended Freight Train Practice; Assignment of Power from the Standpoints of Efficient Service and Economy in Fuel and Maintenance.

Master Blacksmiths' Association.—The twenty-fourth annual convention of the International Railroad Master Blacksmiths' Association will be held at the Hotel Sherman, Chicago, August 15-17, 1916. The following subjects will be discussed: Frame Making and Repairing, Drop Forgings, Tools and Formers, Spring Making and Repairing, Frogs and Crossings, Carbon and High Speed Steels, Case Hardening, Oxy-Acetylene and Electric Welding, Shop Kinks, Heat Treatment of Metals, Piece Work and other Methods, Reclaiming of Scrap Material, Flue Welding.

International Railway General Foremen's Association.—The twelfth annual convention of the International Railway General Foremen's Association will be held at the Hotel Sherman, Chicago, on August 29 to September 1, and not in July as formerly. The following is the list of topics with the name of the chairman of the committee which is to prepare them: Car Department Problems, E. E. Griest, chair-

man; Counterbalancing of the Locomotive and Fitting Up of the Frames and Binders, H. C. Warner, chairman; Classification of Repairs, Robert Wilson, chairman; Relation of the Foreman to the Men, T. E. Freeman, chairman.

American Railroad Master Tinners, Coppersmiths and Pipefitters' Association.—At the annual convention of the American Railroad Master Tinners, Coppersmiths and Pipefitters Association held in Chicago May 22 to 24, the following officers were elected for the ensuing year: President, W. J. Moffett, New York Central Lines, Indianapolis, Ind.; first vice-president, G. B. Hosford, Missouri Pacific Railway, Sedalia, Mo.; second vice-president, W. W. Nash, Illinois Central, Water Valley, Miss.; third vice-president, T. E. Holderby, Chesapeake & Ohio, Huntington, W. Va.; secretary-treasurer, O. E. Schlink, Chesapeake & Ohio, Peru, Ind.

Master Car & Locomotive Painters' Association.—The next annual convention of the Master Car and Locomotive Painters' Association will be held at Atlantic City, N. J., on September 12-14, 1916. The list of subjects to be presented are as follows: The Initial Treatment and Maintenance of Steel Passenger Equipment Roofs, etc.; Headlinings Painted White or in Very Light Shades—How Should They Be Treated and Should They Be Varnished; Is It Economy to Purchase Paints Made on Railroad Specifications; The Shopping of Passenger Cars for Classified Repairs; Railway Legislation and Its Effect on Business. The following questions will also be discussed: To what extent is it necessary to remove trimmings from passenger car equipment undergoing paint shop treatment? How does the hot water and oil method of cleaning locomotives at roundhouses affect the painted parts? Is there any advantage in painting or oiling the interior of new or old steel gondola and hopper cars? Is there anything superior to varnish remover for removing paint from a steel passenger car, considering labor and material costs? Is there anything superior to soap for the cleaning of passenger equipment cars preparatory to painting and varnishing?

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations:

AIR BRAKE ASSOCIATION.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

AMERICAN RAILROAD MASTER TINNERS', COPPERSMITHS' AND PIPEFITTERS' ASSOCIATION.—O. E. Schlink, 485 W. Fifth St., Peru, Ind.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.—J. W. Taylor, Karpen Building, Chicago.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—Owen D. Kinsey, Illinois Central, Chicago. Convention, August 24-26, 1916.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Prof. E. Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Aaron Kline, 841 Lawlor Ave., Chicago. Second Monday in month, except June, July and August, Hotel La Salle, Chicago.

CHIEF INTERCHANGE CAR INSPECTORS' AND CAR FOREMEN'S ASSOCIATION.—W. R. McMunn, New York Central, Albany, N. Y. Convention, October 3-5, Indianapolis, Ind.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—J. G. Crawford, 547 W. Jackson Blvd., Chicago.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1126 W. Broadway, Winona, Minn. Convention, August 29-Sept. 1, 1916, Hotel Sherman, Chicago.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—A. L. Woodworth, Lima, Ohio. Convention, August 15-17, 1916, Hotel Sherman, Chicago.

MASTER BOILER MAKERS' ASSOCIATION.—Harry D. Vought, 95 Liberty St., New York.

MASTER CAR BUILDERS' ASSOCIATION.—J. W. Taylor, Karpen Building, Chicago.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION OF U. S. AND CANADA.—A. P. Dane, B. & M., Reading, Mass. Convention, September 12-14, 1916, "The Breakers," Atlantic City, N. J.

NIAGARA FRONTIER CAR MEN'S ASSOCIATION.—E. Frankenberger, 623 Brisbane Building, Buffalo, N. Y. Meetings, third Wednesday in month, New York Telephone Bldg., Buffalo, N. Y.

RAILWAY STOREKEEPERS' ASSOCIATION.—J. P. Murphy, Box C, Collinwood, Ohio.

TRAVELING ENGINEERS' ASSOCIATION.—W. O. Thompson, N. Y. C. R. R., Cleveland, Ohio. Convention, September 5-8, 1916, Chicago.

PERSONAL

GENERAL

P. A. CAMPBELL, chief clerk in the machinery department of the Chicago Junction Railway has been appointed assistant superintendent of motive power at Chicago, Ill.

J. DICKSON has been appointed superintendent of motive power of the Spokane, Portland & Seattle, the Oregon Trunk, the Pacific & Eastern, the Spokane & Inland Empire, the Oregon Electric, and the United Railways, with headquarters at Portland, Ore. Mr. Dickson was born on June 30, 1872, at Montreal, Que., and was educated in the grammar and night schools of his native town, also at St. Paul, Minn. He began railway work in 1884 as machinist apprentice on the Great Northern, remaining in the service of that road as an apprentice and machinist until 1889. He was later in the service of the Chicago & Eastern Illinois as a machinist at Huntington, Ind., and with the Roanoke Machine Works, Roanoke, Va., until 1891, when he returned to the Great Northern, and served consecutively as machinist, air brake repair man and draftsman until 1898. He was then for two years instructor in Mechanic Arts High School, St. Paul, Minn. In 1900 he again returned to the service of the Great Northern as general air brake instructor. Two years later he was appointed superintendent of shops, and in 1904 was made master mechanic of the Dakota division of the same road. In 1908 he entered the service of the Spokane, Portland & Seattle as master mechanic during the construction of that road. He was promoted to general master mechanic in February, 1914, with jurisdiction also over the Oregon Trunk, the Oregon Electric and the United Railways. The following May his jurisdiction was extended over the Spokane & Inland Empire and the Pacific & Eastern and later also over the electrical and signal departments of all these roads.

J. Dickson

JAMES FITZMORRIS, master mechanic of the Chicago Junction Railway has been appointed superintendent of motive power with office at Chicago.

ELLIOTT SUMNER, master mechanic of the Pennsylvania Railroad at West Philadelphia, Pa., has been appointed superintendent of motive power with office at Williamsport, succeeding I. B. Thomas.

A. G. WILLIAMS, assistant master mechanic of the Pennsylvania Lines West, has been appointed assistant engineer of motive power, succeeding L. B. Jones, transferred.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

O. H. ATTRIDGE, master mechanic of the Atlanta & West Point and the Western Railway of Alabama, has been appointed master mechanic of the Georgia Railroad, with office at Augusta, Ga., succeeding J. H. Gaston, resigned to go to another company.

FRANK J. BAUER, locomotive foreman of the Great Northern at Kelly Lake, Minn., has been appointed master me-

chanic of the Breckenridge division, at Breckenridge, Minn., succeeding S. J. Fero, assigned to other duties.

J. C. Benson has been appointed master mechanic of the Butte division of the Great Northern, at Great Falls, Mont., succeeding A. B. Ford, assigned to other duties.

J. H. Gaston, master mechanic of the Georgia Railroad at Augusta, Ga., has been appointed master mechanic of the Atlanta & West Point and the Western Railway of Alabama, with office at Montgomery, Ala., succeeding O. H. Attridge, resigned, to accept service elsewhere. Mr. Gaston was born at Quincy, Ill., in 1872, and was educated in the public schools. He entered railway service in 1888 with the Louisville & Nashville at Louisville, Ky. He later served on the Cleveland, Cincinnati, Chicago & St. Louis at Indianapolis, Ind.; the Illinois Central at Paducah, Ky., and the Georgia Railroad at Augusta, Ga., until his recent appointment mentioned above.

C. Gribbin, formerly locomotive foreman of the Canadian Pacific at Toronto, Ont., has been appointed district master mechanic, District 4, Ontario division, at Toronto.

Walter Hamilton has been appointed assistant master mechanic, Pennsylvania Lines West, with headquarters at Ft. Wayne, Ind., succeeding F. T. Huston, promoted.

Robert Schule has been appointed master mechanic of the Montana division of the Great Northern, at Havre, Mont., succeeding J. C. Benson, transferred.

George W. Weber has been appointed master mechanic of the Minot division of the Great Northern, at Minot, N. D., succeeding E. English, assigned to other duties.

CAR DEPARTMENT

F. T. Huston, assistant master mechanic of the Pennsylvania Lines West at Fort Wayne, Ind., has been appointed general car inspector of the northwest system of the Pennsylvania Lines West, succeeding O. J. Parks, resigned.

A. H. McCowan, supervisor of car work of the Canadian Northern Lines west of Port Arthur, Ont., has had his authority extended over the eastern lines

J. Rudd, formerly assistant car foreman of the Canadian Northern at Winnipeg, Man., has been appointed car foreman at Kamsack, Sask., succeeding W. Millman, transferred.

R. J. Watters has been appointed assistant general air brake inspector of the Northern Pacific, succeeding D. A. McMillan, assigned to other duties.

C. Wheaton, formerly car foreman of the Canadian Northern at Port Arthur, Ont., has been appointed assistant car foreman at Winnipeg, succeeding J. Rudd, promoted.

SHOP AND ENGINE HOUSE

M. A. Cardell, formerly locomotive foreman of the Canadian Northern at Tollerton, Alta., has been appointed locomotive foreman at Kamloops Jct., B. C., succeeding S. Vincent, transferred.

A. Edwards has been appointed assistant locomotive foreman of the Canadian Pacific at London, Ont., succeeding W. Wright, promoted.

A. T. Hannah, formerly locomotive foreman of the Canadian Northern at Humboldt, Sask., has been appointed locomotive foreman at Hanna, Alta., succeeding N. McLean, transferred.

J. B. Irwin has been appointed general foreman locomotive department of the Chicago, Burlington & Quincy at Edgemont, S. D., succeeding A. G. Pirie, transferred.

N. McLean, formerly locomotive foreman of the Canadian Northern at Hanna, Alta., has been appointed locomotive foreman at Humboldt, Sask., succeeding A. T. Hannah, transferred.

A. G. Pirie has been appointed general foreman locomotive department Chicago, Burlington & Quincy at Alliance, Nebr., succeeding C. L. Emerson, resigned.

S. Vincent, formerly locomotive foreman of the Canadian Northern at Kamloops Jct., B. C., has been appointed locomotive foreman at Tollerton, Alta., succeeding M. A. Cardell, transferred.

F. Williams has been appointed general foreman, locomotive and car departments, of the Wellsville & Buffalo, with office at Blasdell, N. Y.

W. Wright, formerly assistant locomotive foreman of the Canadian Pacific at London, Ont., has been appointed locomotive foreman at Toronto, Ont., succeeding C. Gribbin, promoted.

PURCHASING AND STOREKEEPING

H. A. Clark has been appointed storekeeper of the Grand Trunk at Richmond, Que., succeeding M. E. Martin, enlisted for active service.

W. E. Downing has been appointed storekeeper of the Baltimore & Ohio at Connellsville, Md., succeeding C. G. Sutton.

H. J. McQuade has been appointed purchasing agent of the Lehigh Valley, with headquarters at New York. Mr. McQuade entered the service of the Lehigh Valley as a boy, 29 years ago. His first work was as a clerk in the local offices in Philadelphia. In February, 1902, he was transferred to the general bookkeeping department, and in December, 1903, he was appointed chief clerk to the general auditor. He was elected assistant treasurer of the same road, with office at Philadelphia, Pa., in January, 1909, and remained in that position until June, 1910, when he left the service of the Lehigh Valley to take up other duties. Mr. McQuade now returns to the service of the Lehigh Valley as purchasing agent, with headquarters at New York, as above noted.

H. J. McQuade

F. A. Murphy, district storekeeper of the Wheeling district of the Baltimore & Ohio, at Wheeling, W. Va., has been transferred to the Pittsburgh district, at Pittsburgh, Pa., succeeding E. W. Thornley.

E. A. Paul has been appointed purchasing agent of the New Orleans Great Northern with office at New Orleans, La.

H. Shoemaker, storekeeper of the Baltimore & Ohio at Newark, Ohio, has been appointed district storekeeper of the Wheeling district, at Wheeling, W. Va., succeeding F. A. Murphy.

C. G. Sutton, storekeeper of the Baltimore & Ohio at Connellsville, Md., has been appointed storekeeper at Newark, Ohio, succeeding H. Shoemaker.

I. B. Thomas, superintendent of motive power of the Pennsylvania Railroad at Williamsport, Pa., has been appointed assistant purchasing agent at Philadelphia.

E. W. Thornley, district storekeeper of the Pittsburgh district of the Baltimore & Ohio at Pittsburgh, Pa., has been appointed general storekeeper at Baltimore, Md.

SUPPLY TRADE NOTES

Henry A. Sherwin, founder and chairman of the board of the Sherwin-Williams Company, died on June 25, at his home at Cleveland, Ohio.

George W. Wenz, for several years assistant purchasing agent of the Gould Coupler Company, Depew, N. Y., has been appointed purchasing agent of the company.

The executive departments of the Western Electric Company, Inc., at New York, has been moved from 463 West street to new offices in the Telephone & Telegraph Building at 195 Broadway.

William P. Harper, chief of the purchasing department of the Allis-Chalmers Manufacturing Company and president of the Northwestern Manufacturing Company, Milwaukee, died of apoplexy on May 27.

Edward G. Caughey, assistant chief engineer of the Youngstown Sheet & Tube Company, Youngstown, Ohio, has resigned to become general manager of the Pennsylvania Tank Car Company, Sharon, Pa.

William H. Yetman, for the past two years in charge of the western railroad department of the Pyrene Manufacturing Company, New York, has been appointed railroad sales manager of the company for the entire United States. He succeeds E. L. Kent, who has resigned to become vice-president of the Metal Hose & Tubing Company. Mr. Yetman prior to his becoming associated with the Pyrene Manufacturing Company, two years ago, was hydraulic engineer of the Bethlehem Steel Corporation. His headquarters will be at Chicago. William D. Dorry, one of the company's star salesmen, will be in charge of railway sales in the territory east of Pittsburgh, with headquarters in New York. Mr. Dorry was formerly with the National Biscuit Company.

W. H. Yetman

The business and good will of the Commercial Acetylene Railway Light & Signal Company, New York, except the welding department, has been acquired by the AGA Railway Light & Signal Company, 80 Broadway, New York.

W. E. Greenwood has been appointed assistant manager of the railway sales and fuel oil department of the Texas Company, succeeding L. F. Jordan resigned. Mr. Greenwood's headquarters will be at 17 Battery place, New York City.

C. F. Herington, assistant engineer in the office of the chief mechanical engineer of the New York Central, has resigned to take a position with the Bonnot Company, of Canton, Ohio, as mechanical engineer of the powdered coal department.

The Edison Storage Battery Supply Company has opened a new sales office at New Orleans, La., and C. A. Luckey, who has heretofore been attached to the sales office of the Edison Storage Battery Company in Chicago has been appointed resident manager of the new office.

W. B. Dickson has been elected second vice-president of the Midvale Steel & Ordnance Company. This is a new office. Mr. Dickson has resigned from his position as secretary, but will continue as treasurer. He has been succeeded as secretary by D. B. Gehley, now secretary of the Cambria Steel Company.

Henry M. Shaw, formerly eastern representative of the Gardner Machine Company, Beloit, Wis., has become associated with Sherritt & Stoer Company, Inc., 603 Finance building, Philadelphia, and will represent the company in connection with its regular line, giving special attention to the Gardner company's products.

The Pennsylvania Tank Car Company and the Pennsylvania Tank Line, Sharon, Pa., announce the election of L. F. Jordan as president, and A. S. Maitland as treasurer. Mr. Jordan is a man of wide experience both as a railroad and supply man. He first entered railway service in 1895, as a clerk in the stores department of the Missouri Pacific at Kansas City, Kan., later being promoted to storekeeper in the same office. From 1901 to 1902 he was clerk in the office of the purchasing agent of the Kansas City Southern at Kansas City, Mo. From the latter date until 1905 he was clerk in the office of the general manager of the Kansas City Southern at Kansas City, Mo. From Kansas City he went to Denver, Colo., where he was general storekeeper of the Denver & Rio Grande until 1905, when he returned to Kansas City as purchasing agent of the Kansas City Southern. He left railroad service in 1912 to become assistant manager of the railroad and fuel oil department of the Texas Company, Chicago.

L. F. Jordan

Thomas M. Derickson, at present general manager of the F. B. Zieg Manufacturing Company, will become general sales manager of the A. G. A. Railway Light & Signal Company. Mr. Derickson was born at Meadville, Pa., in 1866. He served his apprenticeship in the Erie shops at Meadville, but later studied civil engineering, and for a while was in the engineering department of the Erie Railroad. Subsequently he engaged in railroad and land surveying in the south, and at one time was also general manager of the Lookout Incline Railway on Lookout Mountain. He was later sales manager of the Champion Iron Works and subsequently became general manager of the Memphis district of the Bell Telephone Company, and then general sales manager of the Galion Iron Works, Galion, Ohio. As noted above, he is at present general man-

T. M. Derickson

ager of the F. B. Zieg Manufacturing Company, Fredericks-town, Ohio, manufacturers of cast iron culvert pipe and the Panama line of road machinery.

W. H. Ivers, formerly with the Baldwin Locomotive Works, has been appointed southwestern representative of the Gold Car Heating & Lighting Company, with headquarters at St. Louis, Mo., succeeding George F. Ivers, who has resigned to become manager of the railway supply department of Shapleigh Hardware Company, St. Louis, Mo.

At a meeting of the board of directors of the American Brake Shoe & Foundry Company, New York, May 17, Otis H. Cutler, president of the company, was elected chairman of the board, and William G. Pearce, vice-president, was elected president. James S. Thompson, William S. McGowan and Clifton D. Pettis were elected vice-presidents.

George T. Ramsey, railroad representative of the Garlock Packing Company, New York, will take charge of the railroad department of Fearon, Daniels & Co., Inc., Shanghai, China. He will sail about August 1. Mr. Ramsey was at one time connected with the American Locomotive Company. He was later connected with the New York Central and also with the American Vanadium Company.

Joseph Thayer Gilman, first vice-president of the Goodwin Car Company, New York, died on June 11 at the age of 52 years. Mr. Gilman had been associated with the Goodwin Car Company since 1903. He was born at Framingham, Mass., in 1864. At the age of 20 he went to India with C. H. Bailey & Co., importers of goat skins, but returned in 1887 on account of ill health. The year following he went again to India and opened a house for Keen Sutterlee Co., Ltd. He later returned to the United States and became associated with John M. Goodwin of the Goodwin Car Company. In 1898, however, he went back to India and opened a house in Calcutta for the firm of Burk Brothers of Philadelphia, manufacturers of morocco. He again became associated with the Goodwin Car Company in 1903. He was for a time second vice-president, but later succeeded to the position of first vice-president. At the time of his death he was in charge of the design and construction of the Goodwin car and the making of all contracts for their lease and sale.

J. T. Gilman

G. R. Delamater has been appointed fuel engineer at the Steelton plant of the Pennsylvania Steel Company. He will be in charge of all coal washings; the supervision of the coal stock, including coking, bituminous, gas, slack and anthracite coal, coke breeze and the disposition of these products to the various departments; sampling of coal; the deliveries of gas, tar, coke and coke breeze, and miscellaneous matters between the various operating departments and the Semet-Solvay Company.

The International Pulverized Fuel Corporation, New York, has filed an application for a charter in Delaware to carry on the business of mechanical engineers and the manufacture of machinery for producing gaseous materials for products for light and heat. The company is incorporated for $100,000 and the names of the incorporators are V. Z. Carachristi, H. F. Ball, Bronxville, N. Y.; George L. Bourne, Mamaroneck, N. Y.; Samuel G. Allen, New York; J. E. Muhlfeld, Scarsdale, N. Y.; LeGrand Parish, Mountain View, N. J., and J. S. Coffin, Englewood, N. J.

On June 6 the stockholders of the Barney & Smith Car Company, Dayton, Ohio, elected as directors A. Clifford Shinkle, Lawrence Maxwell, Charles L. Harrison, Edward L. Heinsheimer and H. W. Lithmann, of Cincinnati, Ohio; Eugene J. Barney, H. M. Estabrook, A. J. Stevens and J. S. Kiefaber, of Dayton. The new members, Messrs. Shinkle, Lithmann and Heinsheimer, succeed James L. O'Neil, of Pittsburgh, and E. L. Potter, of New York, retired, and John Ledyard Lincoln, of Cincinnati, deceased.

The Greenville Steel Car Company, Greenville, Pa., has recently been reorganized and F. L. Fay, formerly general manager, has been elected president and has acquired the controlling interest in the business. James G. Dimmick has been elected vice-president. The company is enlarging its plant to handle more business.

F. L. Fay

Frank L. Fay, the new president of the company, has been treasurer and general manager of the Greenville Steel Car Company and its predecessor, the Greenville Metal Products Company, since 1910. He was born at Cleveland on July 18, 1869, and was educated in the public schools of that city. He entered railway service in 1888 when he became a night watchman at the Cleveland shops of the Valley Railroad, now part of the Baltimore & Ohio. He also served for a while as an operator on that road. In 1889 he went to the New York, Chicago & St. Louis, serving for a time as a station agent and three years in the car accountant's office. From 1903 to 1910 he was car accountant on the Bessemer & Lake Erie. As noted above, he left railway service in the latter year to engage in the railway supply business.

J. G. Dimmick

James G. Dimmick, the new vice-president, was for some time in the construction department of the Pere Marquette. He has been engaged for some years in car construction work and in his new position will have charge of the production department and the management of the factory.

The Central Foundry Company, New York, announces that owing to the increasing importance of its western business, a vice-president of the company will maintain an office in Chicago, and that C. C. Todd, who, for many years, has

represented the company in the west and who about a year ago was elected a vice-president of the company, will open the Chicago office.

On June 15 the stock of the Kansas City Bolt & Nut Company was purchased by Kansas City interests from the J. H. Sternbergh estate of Reading, Pa. Coincident with the transfer of the property the following officers were elected: George T. Cook, president; Solomon Stoddard, vice-president and general manager; H. R. Warren, secretary and treasurer. The board of directors includes Messrs. Cook, Stoddard and Warren, and A. L. Gustin, president of the Gustin-Bacon Manufacturing Company of Kansas City, and E. A. Nixon, vice-president of the Western Tie & Timber Company, St. Louis, Mo. The company has been in existence since 1888, has a plant which covers 15 acres of ground and has an annual output of 3,000 carloads of finished material per year. It employs from 650 to 750 men, and has a distributing payroll running approximately from $500,000 to $600,000 per year. The new organization is increasing the finances of the company and many improvements in the equipment of the plant are contemplated.

G. T. Cook

S. Stoddard

George T. Cook, the new president, was born in Kansas City, Mo., October 14, 1871. He was educated in the public schools of Kansas City and graduated from the University of Kansas. He was in the purchasing department of the Kansas City, Fort Scott & Memphis for several years, and moved to St. Louis at the time the Kansas City, Fort Scott & Memphis was absorbed by the St. Louis & San Francisco. He remained in St. Louis about a year and left to go with the Kansas City Bolt & Nut Company, as general sales manager in June, 1902. He resigned from the Kansas City Bolt & Nut Company in 1910, however, but continued in the railway supply business in Kansas City. On June 15, 1916, he was elected president of the Kansas City Bolt & Nut Company, as above noted.

Solomon Stoddard, vice-president and general manager, was born in Boston, Mass., and educated in Trinity College, Stratford, Conn. He entered the service of the Kansas City Bolt & Nut Company in a minor position in February, 1900, and has worked up to the position of vice-president and general manager.

On May 25 a special meeting of the stockholders of the Pyle-National Electric Headlight Company was held at Jersey City, N. J., for the purpose of changing the name of the company to the Pyle-National Company. The change was made principally because the company is now manufacturing and selling several other devices besides electric headlights, among them the Young valve and valve gear, and that its business in these other lines is growing so rapidly that it is no longer distinctively a headlight company.

P. J. Ford, for years buyer and department manager for Crerar, Adams & Company of Chicago, has organized the P. J. Ford Company with office and store at 619-621 West Washington street, Chicago, and has the selling agency for the Ford Chain Block & Manufacturing Company of Philadelphia, the Indiana Foundry Company, Ltd., of Indiana, Pa., manufacturers of the Sutton sand drier, and several heavy hardware specialties in the railroad supply field. Mr. Ford is president and treasurer of the new company and is a man of long experience in the railway supply field. A native of Chicago, he entered the employ of Crerar, Adams & Company as assistant shipping clerk on June 26, 1883. He remained in that position for three years, was shipping clerk for two years, and subsequently city buyer for five years. For the past twenty-three years he has been buyer and department manager of that company.

The Commercial Acetylene Railway Light & Signal Company, having sold out its railway light and signal business to the A. G. A. Railway Light & Signal Company, will henceforth confine its efforts to the sale of acetylene, and will change its name to the Commercial Acetylene Welding Company. This policy has been adopted because of the rapid development of the welding business, as it has become apparent that the railway and welding business can be better handled by separate organizations. The officers of the Commercial Acetylene Welding Company are: E. C. Benedict, president; F. S. Hastings, vice-president; M. J. Quinn, secretary and treasurer; G. Mayer, assistant secretary and assistant treasurer. The directors include these officers and Edward Beers, Robert S. Sharp, and A. V. Conover. M. M. Smith, assistant to the general manager of the Commercial Acetylene Railway Light & Signal Company, has been promoted to the position of general manager of the Commercial Acetylene Welding Company. The office of the company is at 80 Broadway, New York.

M. M. McCallister, inspector of building shops at Schenectady and Lima for the New York Central, has been appointed boiler expert of the American Flexible Bolt Company, with headquarters at Pittsburgh, Pa. Mr. McCallister was born at Curleysville, Pa. He began his business career as the first apprentice on the Pittsburgh & Lake Erie. When he left that road he was made field erector of the James P. Witherow Company, of New Castle, Pa., manufacturers of the Heine boilers. From this position he went with the American Bridge & Iron Company in charge of the Roanoke, Va., shops, and later to the Norfolk & Western as assistant foreman of shops at Roanoke. He was next appointed assistant superintendent of the Richmond shops of the Richmond Locomotive Works, now a part of the American Locomotive Company. From here he left to become foreman boilermaker of the Lake Shore & Michigan Southern at Collinwood, Ohio. He was next appointed superintendent of the Erie City Iron Works, at Erie, Pa., leaving this position later to go as superintendent of John Brennan & Company, at Detroit, Mich., who manufacture stationary and marine boilers. He was next appointed superintendent of the Weil Boiler Company, with headquarters at Indianapolis, Ind. While here he designed and put on the market the Weil smokeless boiler, which has since proven a great success. From this position he went with the New York Central, the service of which company he now leaves to become boiler expert of the American Flexible Bolt Company.

CATALOGUES

LOCOMOTIVE SUPERHEATERS.—Bulletin No. 1, recently issued by the Locomotive Superheater Company, deals with the subject of superheater header castings.

EXPANSION JOINT.—Catalog "A," recently issued by the Ross Heater & Manufacturing Company, Buffalo, N. Y., illustrates and describes the Ross crosshead-guided expansion joint for high and low pressure steam, oil, gas and water piping.

AUTOMATIC FIRE DOORS.—The Franklin Railway Supply Company has recently issued a bulletin descriptive of the Franklin No. 8 butterfly type fire door. The bulletin shows how the door is operated and tells how it affords protection for the engine crew.

STONE TOOLS.—The Chicago Pneumatic Tool Company has issued bulletin No. 192, which describes and illustrates the various pneumatic tools used in the cutting, surfacing and quarrying of building stones. Numerous other tools and accessories are also included.

MEASURING COAL LOADER.—Roberts & Schaefer Company, Chicago, have just issued a very well illustrated leaflet descriptive of their Rands measuring coal loader for locomotive. The leaflet is printed on heavy coated paper so that the illustrations show details clearly.

GAS ENGINES.—Bulletin No. 405 recently issued by the National Transit Pump & Machine Company, Oil City, Pa., deals with the company's types GH4A and GH4B, four-cycle, single-cylinder horizontal gas engines. These engines are supplied in 50, 75, 100 and 150 h.p.

PIPE CUTTERS.—The Borden Company, Warren, Ohio, has just issued a 16-page booklet concerning its die stocks and square end pipe cutters. These tools are described in detail with unusually clear illustrations, giving a comprehensive idea of their construction and operation.

ELECTRICAL APPARATUS.—Among recent publications of the Sprague Electric Works, New York, are Bulletin No. 49600 relating to flexible steel armored conductors, flexible steel conduit, stamped steel boxes and fittings and tools, and Bulletin No. 48907 dealing with the company's 500 lb. electric hoists, type I-5.

TIE TAMPING OUTFIT.—The Ingersoll-Rand Company has issued a bulletin describing the methods used and the results obtained with pneumatic tie tampers as employed on steam and electric railways. The booklet contains numerous illustrations showing how the tampers are used and illustrating the various parts of the equipment.

WHEELBARROWS.—The Kilbourne & Jacobs Manufacturing Company has issued a 30-page catalog No. 41 describing its line of steel and wood wheelbarrows, concrete carts, drag and wheel scrapers, dump cars and plows. Special attention is directed to the abandonment of certain designs, thus permitting greater standardization of the line.

LOCOMOTIVE APPLIANCES.—Bulletin No. 110, issued under date of June, 1916, by the Economy Devices Corporation, deals with the lateral motion driving box. This is designed to allow flexibility in engines with long wheel bases and to permit the employment of additional driving axles without increasing the length of the rigid wheel base.

LOCOMOTIVE APPLIANCES.—Two recent bulletins of the Franklin Railway Supply Company, New York, deal respectively with the Franklin automatic driving box lubricator and McLaughlin flexible conduits. Both booklets illustrate and describe the devices with which they deal, and contain information relative to their application, inspection and repair parts.

PAINT.—The Sherwin-Williams Company, Cleveland, O., has issued an interesting illustrated booklet of 52 pages in commemoration of the company's fiftieth year of business, compiled as a record of the important events in the company's history. It contains articles by various officers and is illustrated with photographs of the plants and officers at various periods.

DRINKING FOUNTAINS.—The Henry Giessel Company, 28 East Jackson boulevard, Chicago, has recently issued an illustrated booklet describing the "North Pole" sanitary drinking fountain, designed for use in passenger cars. The booklet includes a detailed explanation of the apparatus accompanied by a diagrammatic illustration, and photographs of installations on various railroads.

ELECTRIC HOISTS.—Bulletin No. 48906, recently issued by the Sprague Electric Works of the General Electric Company, deals with the company's type S-1 electric hoists of one-half ton and one ton capacity. The bulletin shows for what services the hoists are best adapted and gives detailed descriptions and specifications. Illustrations are shown of the cranes and of typical installations.

OXYGEN AND HYDROGEN GENERATORS.—Catalogue No. 3 recently issued by the International Oxygen Company, New York, deals with the I. O. C. Bipolar oxygen and hydrogen generators. The book touches upon the advantages of using the generators as against buying the oxygen or hydrogen in tanks. It also deals with the growing use of hydrogen and considerable space is given to the economy, flexibility, etc., of I. O. C. Bipolar apparatus and to the purity of the gases generated by it. The latter half of the booklet goes into detail concerning the design of the generators and the generation of the gases. The book is well illustrated and well printed.

STEEL PIPE.—Bulletin No. 26, issued under date of April, 1916, by the National Tube Company, is a book of 52 pages devoted to the subject of "Autogenuous Welding of National Pipe." The booklet is very well illustrated, and contains extracts from a number of publications, the various articles dealing respectively with the following subjects: Welding in Gas Distribution; Gas an Important Factor at the Exposition; Welding Suburban Pressure Gas Mains; Welded Pipe Work; Oxy-acetylene Welding in Pipe Work; Efficiency of the Oxy-acetylene Welded Joint; Economies of Welded Pipe Connections, Strength of Thermit Welded Pipe; Oxy-acetylene Welding and Cutting Costs, etc. The various articles and illustrations show how the welding is done, and considerable attention is paid to the advantages of welding pipe on the one hand, and to the strength and general efficiency of National welded pipe on the other.

CAR LIGHTING.—Bulletin No. 154, issued under date of March, 1916, by the Electric Storage Battery Company, Philadelphia, Pa., describes in considerable detail the E. S. B. constant voltage axle lighting system. The bulletin in its 12 pages contains four parts: I, General Principles and Advantages; II, Method of Operation; III, Details of Construction, and IV, Performance Records. The fundamental principle of the E. S. B. axle system is constant voltage as distinguished from constant current. The operation of the system is fully explained in part II. The distinguishing feature is the use of the Rosenberg type of dynamo wherein the main field is produced by a magneto motive force developed by the armature winding. It is explained how, by the use of this type of dynamo, and by the use of the Wheatstone bridge method of field control, the pole changer and the lamp regulator are eliminated as are also the danger from overload and reversal of polarity. This part of the bulletin also explains why it is not necessary to have any levers, pivots, carbon piles, vibrating contacts or moving parts (except in the automatic switch) on the control panel.